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PROCEEDINGS, SEVENTH ANNUAL CONVENTION, NATIONAL COMMERCIAL GAS ASSOCIATION.

HELD IN DENVER, COL., OCTOBER 24 TO 28, 1911.

FIRST DAY—AFTERNOON SESSION.

The President introduced Mr. Robert K. Clark, of Chicago, who read the following paper:

SOME NOTIONS OF A MANUFACTURER.

The welfare of the gas company and that of the manufacturer of gas appliances are so inseparable that it seems to me a short discussion of the points of contact from a commercial standpoint that exist between the manufacturer and the majority of the members of this Association would be helpful to us both.

The interests of the vendor of gas and the manufacturer of gas appliances are the same—the placing of gas consuming apparatus with the public. The two have worked together to increase the popularity and convenience of gas and the ways it may be applied. Lighting simplicity, beauty and efficiency have been carried to a point where gas is an easy competitor with electricity in many fields. For cooking processes, appliances of wide difference in capacity and price and of great convenience are at command. Hot plates, cookers, double oven ranges, cabinets, some large and commodious, others small and compact, and water heaters of varying sizes are all a modern necessity where gas is available. The ordinary, simple uses for gas are well supplied and the appliances are easily placed. Beyond this, the industrial department is able to meet almost any need for heat, frequently with an appliance of regular manufacture and, if not, special appliances can be supplied. As my particular interest is naturally with cooking apparatus for domestic use, let me say a word about the popular cabinet type of range.

We are agreed, I presume, that the so-called cabinet is the ideal cooking appliance, and that the interests of manufacturers, gas company and consumer are all furthered by its increasing use. Its appeal to the housewife was so general that a demand arose for a range embodying its improvements, but of such size that it could be placed in smaller kitchens. The short cabinet was the result with its numerous variations.

Any radical shortening, however, of the standard cabinet results in compromises—the spoiling more or less of its very merits. The demand at last has been for a cabinet to go in the smallest kitchens, and as a consequence the short cabinet which was fairly convenient at the start has been steadily shrinking. The top burner space has been reduced and the border cut down; the oven and broiler often modified and allowed to overhang the cooking burners on one side, till there is very apparent approach to the straight, elevated oven type, which experience has shown is far from ideal.

Manufacturers have, and will continue sinning, as long as there is a demand, but the gas company solicitor should put the ever-shortening cabinet behind him and have recourse to it only as a last resort. The short cabinets have their place; but, where room permits, the full cabinet is by far the most satisfactory stove.

Let me urge the N. C. G. A. to use its influence with architects to give proper dimensions to the kitchen and so allow for the more satisfactory kitchen appliances and their easy use. Also, cannot some plan be worked out to make it worth while for the solicitor to put his effort on stoves in the order of their actual desirability? First: Standard cabinets; second, short cabinets; third, double oven stoves, etc. The temptation is to get an average stove and then sell it to everybody, when possibly one-fourth or one-fifth of your patrons would prefer a better article if it were shown them.

The manufacturer of appliances and the gas company are together in the furtherance of the use of gas consuming apparatus, but, in regard to the details of construction of the regular cooking appliances, the buyer and the manufacturer are not always agreed. What shall be the proper construction of these appliances and what shall be their cost is where opinions diverge,

The manufacturer aims to make as efficient, as serviceable and as salable a piece of goods as he can for the price that the market warrants. Ingenuity and experiments, coupled with experience and contact with gas companies all over the country, have brought out new ideas in design and construction, and each manufacturer has developed what, from the evidence, seemed best to fill the demand. The purchaser of appliances has first selected from what has been offered, then has requested special features, and the final development has been the drawing up of a set of specifications. The manufacturer has had to meet much of this demand for special features, and this has combined to produce new construction. Requirements have, however, been so divergent that the numbers of ways a stove can be built are almost beyond belief.

As a simple instance of this, some companies use needle valves, some lever cocks, some ask for valves on the top manifold with cocks

on the oven. Again, some prefer drilled burners, while others believe in sawed; some two-piece, others solid-cored. The combinations possible with just the differences mentioned amount to very many for one stove. As an example of what this leads to, let me mention a specific instance. I know one (a square stove) that can be furnished in 180 different ways, and in reality in many more. These are differences that must be made before the stove is crated so that the selection of a particular type for stock is most difficult.

The proof which appeals to me, that many of the requirements are captious or inadvisable, lies in the fact that the opinions of different companies, operating under practically similar conditions, and each spending large sums of good money comparing and testing stoves and water heaters, are diametrically opposed. The drawing up of specifications has been the natural outcome of experience with stoves of poor manufacture, since specifications simplify the work of the buyer by eliminating at once certain makes.

The making of these specifications is interesting, and frequently advisable, but I believe only in a general way. No company has attempted to go as far as I have heard it advocated; that is, to point where one repair would fit all the makes handled. Though ideal, this would be manifestly impossible, as it is difficult enough for each manufacturer to keep his own parts coming so that they are interchangeable for similar stoves of his own manufacture. Besides it would do away with all variation in design for many parts of the stove.

The trouble with specifications that go into into minutiæ is that they tend to reduce the initiative of the manufacturer. Without detailed restrictions he is able to use his ingenuity to develop ideas in construction and material that can only be tested out in use. Many things can be done in more than one way, and be done equally well; as, for instance, in the laying out of a new railroad, after careful surveys, and with certain grades not to be exceeded and certain points to be covered, a satisfactory line is established. It is an axiom that, with more work and a greater expenditure of money, a better line could be run. With still further effort, a superior route could be mapped out. Why, then, in the stove business, should one method of accomplishing a result be seized upon as the only admissible solution, when another at hand has equal merits, or one still better might be developed?

As a concrete example, let me cite the matter of the air mixer on the ordinary range burner. One arrangement provides the mixer end of the burner with a ground-faced, cast iron web, against which a disk of cast iron with proper openings is allowed to rotate to vary the air admission. Another replaces the cast iron web with a steel disk and a steel outer cap, instead of cast iron shutter. The inside disk is fixed, the outside one rotates. The result is equally good in giving an easy, satisfactory adjustment with tight fit, and neither is foolproof. The arguments against each are about a standoff and of little weight. The cast iron webb may break and the whole burner be spoiled; the steel disks may rust and stick, but neither happens, as far as I know, to any extent. However, both may be poor for the consumer, for as soon as the inspector has made the adjustment the consumer proceeds to take advantage of the simplicity of the contrivance and as quickly spoils the working qualities of the burner.

Granted that the two methods are satisfactory, if either method proves cheaper or more advisable to the manufacturer, why should the gas company insist that but one arrangement be accepted? What is the use in requiring all manufacturers to conform to one special method?

I believe minute specifications a mistake from both sides, especially when uniformity among buyers does not exist. Under a rigid specification ruling, stoves of superior workmanship and appearance may be refused by one company on details that coincide directly with the specifications and requirements of another careful company. From the manufacturer's standpoint the matter presents a great deal of difficulty. He may be supplying a large number of stoves which are giving satisfaction, but is barred from selling certain companies on account of unimportant structural details.

If these details involve radical changes, it means a new line of stoves, if he is to get that particular business. Should he decide to make the special appliance, he does so at his peril; for the price must be low, no volume of business is assured, and the stove may not be something desired by other companies. This may be easily considered the manufacturer's gamble, but it certainly is a hardship.

It probably is unnecessary for me to say that the buyer can impose whatever conditions he likes, but I maintain it is to the interest of both that detailed requirements should not be demanded. My appeal, therefore, as a manufacturer, to you who buy appliances where you deem specifications are a necessity, is that you make them on general rather than narrow lines, looking toward satisfactory results rather than minor details of construction.

Discussion.

The President said the paper was open for discussion. He hoped some of the stove manufacturers would take part in it. Mr. Parker said that when asked by the Paper Committee to open the discussion, and on reading the paper having agreed with Mr. Clark in most of that which he had written, he concluded to take a reasonable length of time to say nothing. [Laughter.] He agreed with Mr. Clark that the welfare of the manufacturer and gas company could not be separated; and a like link seemed to bind to the consumer, whose interests must be considered. They were passing through what might be termed the short cabinet period, in which event the responsibility rested with the salesman or the solicitor, relieving the manufacturer. Often soon after a short cabinet was sold and installed, a reasonable space is found where a longer cabinet would have fitted. Mr. Clark advocates the education of the architect; but if they educated the man building the house the latter would educate the architect right quickly. The man whom you want to reach is the one building the house. Of course, he was not laying down laws for a gas company to follow, being purely a salesman. The gas companies then ask for special specifications, and his principals welcomed special specifications on large orders. Mr. Clark covered and voiced to some extent, the sentiments of the manufacturers, and he did not think any manufacturer's desire was other than to give to the fraternity a stove embodying all the appointments that cause easy and ready selling. And they needed the help of gas companies to produce such an article. They know the wishes of the consumers, and there is no question but that, as before, all of these problems will be solved. He thought Mr. Clark had given them an excellent paper, and thought all would agree with him in considering the paper both excellent and timely. Many would be pleased to hear from others in its discussion. Would Mr. Sard begin the debate?

Mr. Sard said he had planned to keep quite still, because Mr. Clark's opinions absolutely coincided with his own. He had often spoken with Mr. Clark on the subject and it seemed that they possibly could do something definite along the lines put forth in the endeavor to improve matters. As Chairman of the Committee on Relations with Manufacturers the past year, he endeavored to do some missionary work, although he did not specify these in the report, thinking they would only narrate definite results accomplished when the Handbook was printed. They never would accomplish anything unless a start was made. He thought possibly the best way might be to interview a few members of the larger companies as to forming and agreeing on certain general specifications. That was merely a step. It was not proposed to cover all the specifications at the outset. In fact he had planned to write Messrs. Robert Clark, L. B. Young, Roper, Mayer, Barrows, McLean and Fogg, to meet him at the Brown Palace Hotel that evening. While he did not believe they could do anything definite, still they could get an expression of opinion wherefrom possibly something might be worked out which would be of advantage to the industry.

The President said that, having heard from a number of the manufacturers, he wondered if the representatives of the gas companies would not like to take part in the discussion.

Mr. Turrentine said that in Houston one year the percentage of sales in the cabinet type of ranges was about 10, and this year they were between 30 and 35 per cent.; the larger sizes were best liked. The reason was that a large cabinet range (of two ovens and a broiler) meets the requirements of most any family in Houston, and they use gas exclusively for cooking purposes. They had followed up several installations where large coal and wood ranges were used. The wood stores are now out altogether, and in their places are installed the best range in stock. This gave a chance to advocate water heaters. Their records showed the percentage of sales this year was at least 30, and they had sold some of the largest ranges made by manufacturers. Of course, they do not sell very many of the largest types; but stoves with an 18-inch oven and 14-inch auxiliary oven and broiler are the types favored. On that basis he believed, in another year, 50 per cent. of their sales would be in that line of stoves. He spoke from actual experience. [Applause.]

Mr. Hanlan said that while he did not particularly wish to speak on the subject, still it appealed to him that some expression on the matter should be made from the gas companies side. He knew it was

a rather delicate subject, but as they all came there to learn something, the best way to learn was to discuss freely. He thought, in fact felt, that the matter of specifications was annoying to the manufacturer. The company he served had been buying ranges according to specifications prepared by as able a designer in gas appliance construction as he believed there was in any other country. He thought at one time it was advisable to have ranges conform to certain specifications, embodying certain features of construction that the experience of gas men would seem to warrant. If he were wrong about that he hoped the manufacturers would forgive him. Looking from the standpoint of the man trying to sell gas ranges, it was right to buy ranges according to specification, but the latter should not only be fair but such that would in no way prevent improvements the manufacturer could make on his stove or other product. That was his personal opinion. Recently they had been threatened with litigation in one of their towns that had inception in respect to the connection of gas ranges. Showing the Common Council the specifications under which they were buying ranges, we assured them that the specifications were all right, and that the possible difficulty complained of would not prevail. Their reply was: "We will not rule against stoves built under those specifications, and you can connect them." At a meeting of this kind they were entitled to get in candid conversation with the manufacturers. He believed, as one selling their product, that the manufacturer was entitled to every consideration. He had met most of the manufacturers and found them to be not only fine gentlemen but men from whom most gas men could learn something.

Mr. O'Donnell said, from a salesman's standpoint, it was the duty of those in charge of the buyers' division of the business of the gas companies of this country to weigh every consideration. As a salesman amongst the consumers, he believed that every consumer would rather have a larger range than one of the smaller cabinet types. Yet, at the same time, as a salesman, he humbly advised that the men who looked up the specifications, or who were to purchase the gas ranges for the companies, should take into consideration not only the buildings going up, but the old buildings as well. There were thousands of home owners to-day purchasing gas ranges, and there were individuals not owning their homes who would buy a small cabinet gas range if possible to have it. So, therefore, he thought the small cabinet necessary in some cases. He was not saying that for every city or town, but there were cases where small cabinet gas ranges could be ready for those who needed them. In his district he sold a great number of cabinet gas ranges and had sold about 90 per cent. of the larger types. The small one sometimes led to the sale of a large one.

Mr. R. E. Gibby, speaking from the standpoint of the salesman, believed in the cabinet range and thought the manufacturers who get it out were certainly entitled to much credit; but, as a prior speaker had said, they were not only taking care of new buildings, but had also to care for buildings already constructed. The latter meant they were replacing old installations. The old types of ranges were wearing out year after year, and they were building up a new business, carrying practically a new rate of consumption. So, he thought, when considering the difficulties coupled with the narrower types of construction, something that gets to about 40 inches or 42 inches at least, they could go into places where they could not go with any other type of cabinet range. In one installation just completed they put 34 ranges in an apartment house where it would have been impossible to put the larger type, through the nature of the kitchens arranged for before the buildings were erected. For such reasons he thought the smaller type had its place. He, of course, failed to know a salesman who would select that type of range in place of the other, because of its particular convenience, for they all knew that the larger the broiler and the larger the space on the top of the range, the more convenient it was to those doing the cooking. From his standpoint he believed the cabinet range proposition a good one, especially as 75 per cent. of his sales this year had been of the cabinet type. He believed in it because it was a good range and of the type which in a short time would be the universal range. The old kitchens were to be replaced by either a shorter type, or the one preferable for the use of a regular cabinet. All of his installations were with that end in view. The cabinet range was his range, and he believed the manufacturers could begin building on this proposition from all sides.

The President asked Mr. Clark to close the discussion, and that gentleman replied, "Mr. President I have nothing to add."

(To be Continued.)

Surface Combustion.

By Prof. W. A. Bone, D.Sc., Ph.D., F.R.S., Fuel and Metallurgica Departments, the University of Leeds, England.

[A lecture delivered on the occasion of the Sixth Meeting, American Gas Institute, St. Louis, Mo., October 19 to 21, 1911.]

Mr. President and Gentlemen: I am deeply sensible of the honor you have conferred upon me in inviting me to cross the Atlantic for the purpose of laying before you some of the results of the investigation on the industrial applications of "Surface Combustion." My pleasure in accepting your invitation was all the greater because I believe that this Continent, with its courageous industrial enterprise, and its vast resources in gaseous fuels, will afford a splended field for the practical development of our new methods.

The problem of the influence of hot surfaces upon gaseous combustion is one which, from a purely scientific standpoint, has engaged my attention for many years past, and as my recent work has been the direct outcome of earlier scientific investigations, it will be appropriate for me, by way of introduction, to explain briefly the present position of science with respect to this important subject.

You will readily understand that a matter which is of great scientific interest, as well as of practical utility, can hardly be dealt with within the limits of a single lecture, especially when a considerable part of the time must be devoted to actual experimental demonstration. I must necessarily compress my remarks into the smallest possible compass, consistent with clearness, omitting many points of secondary interest which otherwise it would have been profiting for me to discuss. I must make many statements both of fact and of opinion without advancing any demonstration or proof of them; I can only ask you to accept such statements as coming from one who, having devoted many years to the advancement of the science of combustion, would not willingly mislead you.

It would perhaps help you to an understanding of what is implied by the term "*surface combustion*," if I (first of all) explain certain facts which differentiate it from the more familiar and perhaps better understood processes of combustion as they occur in ordinary flames. In the first place, I would have you understand that all hot surfaces have an accelerating influence upon chemical changes in gaseous systems. A recognition of this fact is of fundamental importance. It may be laid down as a well established principle that if at any temperature a gaseous system A, tends to pass over into another system B, contact with a solid at the same temperature will accelerate the process.

To take a very simple example. In a mixture of hydrogen and oxygen in their combining proportions (electrolytic gas) be maintained in an enclosure with smooth glass walls at a temperature of (say) 450° C., there would certainly be a tendency to form steam, but the rate of change would be negligibly small. If, however, there be brought into the system some porous, solid material at the same temperature so that a large surface is exposed to the gases, the rate of change would at once be rapidly accelerated in the layer of gas immediately in contact with the hot surface. Steam, the product, would diffuse outwards from the surface, and the supplies of hydrogen and oxygen at the surface would be renewed by diffusion inwards. Thus combustion would proceed heterogeneously at the surface until the transformation of the original electrolytic gas into steam was complete. In the circumstances just cited, the rate of combustion, although now quite measurable, would probably be insufficient to cause any self heating of the enclosure. The temperature would remain at 450° C., which is well below either the ignition temperature of the combustible mixture or the point at which a solid would attain even incipient incandescence.

It is, therefore, necessary to distinguish between two possible conditions under which gaseous combustion may occur, namely: (1.) *Homogeneously*—that is to say, equally throughout the system as a whole, at temperatures *below* the ignition points *slowly and without flame*, and at temperatures *above* the ignition point *rapidly and with flame;* and (2.) *Heterogeneously*, or only in layers immediately in contact with an incandescent surface ("surface combustion"). It is also necessary to remember that, *ceteris paribus*, the heterogeneous surface combustion is a faster process than the normal homogeneous combustion of ordinary flames.

It has long been recognized as a scientific anomaly that metals of the platinum group have power of inducing gaseous combustion, more particularly that of hydrogen, but it has hitherto been generally considered that in industrial heating operations contact of all

flame with surfaces should be avoided. Indeed, it was a favorite dictum of Frederick Siemens, who was the first to impress upon technologists the importance of radiation in furnace operations, that hot surfaces by promoting dissociation must necessarily hinder combustion. And in view of the great influence which Siemens exercised on contemporary thought, it is perhaps hardly to be wondered that technologists have hitherto never realized the possibilities of surface combustion in the field of industrial heating operations. I am convinced, however, that Siemens was wrong in his judgment concerning this important matter.

It may be profitable for us to consider for a moment how far it is possible to accelerate the process of combustion in ordinary flames. We are apt to think of ordinary flame combustion as an instantaneous process, whereas, when considered in terms of what I may call "molecular time," it is certainly a very slow transaction. Thus, for example, when electrolytic gas is ignited by a spark near the closed end of a tube, the flame is initially propagated by conduction with a uniform slow velocity of 20 meters per second, and during this preliminary period of "*inflammation*," as it is sometimes termed, the total duration of chemical change in each successive layer of gas is of something like the order of one-fiftieth part of a second. But this is at least one hundred million times as long as the average interval between successive molecular collisions in electrolytic gas at the ordinary temperature. The conditions prevailing during the initial period of "*inflammation*" in a gaseous explosion correspond to those in ordinary flames, and it is at once apparent how very slow is the actual chemical change when viewed from the standpoint of molecular time.

But after the flame has traveled a short distance along the tube it is rapidly accelerated, under the influence of compression waves reflected from the closed end of the tube, until a new condition known as "detonation" is set up. In "detonation" the flame is propagated through the mixture by adiabatic compression at an enormously great and constant velocity, amounting in the case of electrolytic gas at atmospheric pressure to no less than 2,820 meters, or about 1¾ miles per second. The combustion now proceeds under conditions of maximum intensity, both as regards the actual duration of chemical change and the temperatures produced in each layer of the burning gases. Some years ago, in conjunction with Dr. Bevan Lean, I found that the duration of chemical action in each successive layer of electrolytic gas in which "*detonation*" has been determined, does not exceed one five-thousandth or possibly one ten-thousandth part of a second, and Mr. D. L. Chapman, of Oxford, has calculated that the temperature attained in the explosion wave is 4,265° C. Therefore, it would appear that, although in "detonation" the duration of chemical change in each successive layer of electrolytic gas is probably about 100 times shorter than in the preliminary period of "inflammation," it is still at least a million times as long as the average interval between successive collisions.

In order to give you visual evidence of the validity of this conclusion, I will throw on the screen a photograph taken by Prof. Harold B. Dixon, of Manchester, of the progress of an explosion in electrolytic gas, from its origin at a point a few inches from the closed end of a horizontal glass tube up to the attainment of its maximum force and intensity in detonation. (Fig. 1.) The flame was photographed on a highly sensitive film moving vertically at a velocity of about 50 meters per second, and the graph thus traced on the film was, therefore, compounded of the horizontal velocity of the flame along the tube and the vertical velocity of the film. The black line on the photograph is due to a reference mark made by gumming a strip of black paper on the tube at a distance of one meter from its closed end. You will observe that the flame was initially propagated through the explosive mixture with a comparatively slow uniform velocity. Its luminosity during this initial period of "*inflammation*" (which corresponds to the conditions of ordinary flames) was comparatively feeble, and, from the slope of the graph, it is evident that its velocity was much slower than that of the vertical motion of the film. After traversing about 0.5 meter along the tube, its velocity was accelerated, and simultaneously the intensity of the combustion increased, as is indicated in the photograph by a brightening of the flame. The acceleration of the flame continued until, at a point just beyond the reference mark, "*detonation*" was set up. At this juncture the flame suddenly increased in brilliance and dashed forward through the mixture at a velocity many times greater (as a matter of fact more than 50 times) than the vertical velocity of the film; at the same instant a strongly luminous wave of compression (called the "*retonation wave*") was sent backwards through the still burning gases. The luminous track of this retonation wave is to be ascribed to its accelerating influence upon the residual combustion in a mixture which had already been "inflamed," and it is evident from the photograph that this after-burning continued even after the "retonation wave" had been reflected back again from the closed end of the tube. Whilst this photograph has no *direct* bearing upon the question of surface combustion, it nevertheless proves beyond all question that the conditions prevailing in ordinary flames are such as admit of a great acceleration of the combustion, and it will, I hope, help you to understand what I shall subsequently refer to as the intensifying action of an incandescent surface upon gaseous combustion.

The influence of hot surfaces upon combustion at low temperatures seems to have occupied the attention of several chemists; Dulong and Thénard and (independently) Döbereiner, in France; Sir Humphrey Davy, William Henry, Thomas Graham, Faraday and de la Rive, in England, during the first third of last century; but no one of these distinguished men succeeded in evolving a satisfactory theory of the phenomenon, nor, with the exception of the famous "Döbereiner Lamp," was there any practical outcome of their efforts. In 1836, after a long but abortive controversy between Faraday and de la Rive, interest in the subject dropped and was not revived again until recent years. My attention was first drawn to the subject during the course of an investigation on the mechanism of hydrocarbon combustion at low temperatures, which I was then engaged upon in conjunction with Mr. R.V.Wheeler and others of my pupils at the Owens College, Manchester (now the Manchester University). The subject soon became so absorbingly attractive that we embarked upon what proved to be a long inquiry into the influence of a great variety of hot surfaces upon the combination of hydrogen and oxygen at temperatures below the ignition point. The inquiry has also included other cases of slow combustion, and I am hoping that experiments which are now being carried out in my laboratory at Leeds University will enable us to materially advance the science of the subject.

It would, however, be premature for me to attempt any prediction of our final conclusions, because several points remain to be cleared up; but I may safely say that our experimental results justify the conclusion that the power of accelerating gaseous combustion is possessed by *all* surfaces at temperatures below the ignition point in varying degrees dependent upon their chemical characters and physical texture. Moreover, the "activity" of a given surface can be enhanced or diminished at will by previous special treatment in a truly marvellous manner; thus, for example, in the case of the combination either of hydrogen or of carbon monoxide with oxygen in contact with a non-oxidizable metal or non-reducible oxide, the "activity" of the surface may be greatly stimulated by previous contact with the combustible gas and, conversely, may be diminished by previous contact with oxygen. Again, there is abundant evidence that the actual surface combustion is dependent upon a prior "absorption" (or condensation) of the combustible gas and (possibly also) of the oxygen by the surface (although to what extent the oxygen is involved is not as yet perfectly clear). The "absorbed" (or condensed) gas becomes "activated" (probably "ionized" as the physicists would call it) by association with the surface. Finally, certain important differences have been established between ordinary homogeneous combustion and heterogeneous "surface combustion;" thus, for example, whereas the presence of water vapor certainly accelerates, if it is not essential to the homogeneous combustion of carbon monoxide, it greatly retards its heterogenous combustion in contact with a surface such as fireclay; or, again, whereas methane has a much greater affinity for oxygen than either hydrogen or carbon monoxide in ordinary flames, a hot surface, by virtue of some "selective" action, will completely reverse the usual order of things, a remarkable circumstance than which no better proof could be afforded of the reality of surface combustion.

My next contention, and one which leads right up to the main theme of my discourse, is that if hot solids possess the power of accelerating gaseous combustion at temperatures in the neighborhood of the ignition point, the same power must also be manifested at higher temperatures, and especially so when the surface itself becomes incandescent. Indeed my belief is that not only does the accelerating influence of the surface upon combustion rapidly increase with the temperature, but also that the difference between the powers of various surfaces (which at low temperatures are often considerable) diminish with ascending temperatures until at bright incandescence they practically disappear. If, therefore, an explosive gaseous mixture is either injected on to or forced through the interstices of a porous refractory incandescent solid under certain con-

ditions, which will be hereafter explained, a greatly accelerated combustion takes place within the interstices or pores; or, in other words, within the boundary layers between the gaseous and solid phases wherever these may be in contact—and the heat developed by this intensified combustion maintains the surface in a state of incandescence *without any development of flame.* Such conditions realize my conception of "*flameless incandescence surface combustion*" as a means of greatly increasing the general efficiency of industrial heating operations wherever it can be conveniently applied.

There are two further points which I particularly wish to make clear to you. In dealing with gaseous interactions at high temperatures it is necessary to think in terms of what I may call "molecular" dimensions. Our ordinary units of time, space and mass are altogether too gross and must be discarded, if we would wish to form a true mental picture of the mechanism of combustion; when, therefore, I speak of combustion as occurring "*within the interstices or pores*" of an incandescent solid, it must be understood that I mean "porosity" in a molecular sense. A solid may appear to the eye as dense, and yet may be highly permeable to the molecules of a gas; from this point of view it is only vitreous surfaces, such as glass, which are (relatively speaking) non-porous to gases, and even glass, when it becomes devitrified, is sufficiently porous to induce a slow surface combustion.

In the second place, I want to emphasize the fact that the incandescent solid plays a specific role in this surface combustiou; it is no mere idle looker-on at the surging crowd of reacting molecules which swarm around it. On the contrary, it so galvanizes and incites the dormant affinities between the combustible gas and oxygen, that the stately minuet of ordinary flame combustion gives place to the wild intoxication of the Venusberg. The manner in which the surface acts is still perhaps a matter of conjecture, but the fact that it so acts can no longer be disputed. In a discussion which took place at the British Association in 1910, Sir J. J. Thomson insisted that combustion is concerned not only with atoms and molecules, but also with electrons—*i. e.*, bodies of much smaller dimensions and moving with very high velocities—and suggested that "in reference to the influence of hot surfaces in promoting combustion, to which Prof. Bone had drawn attention, it was not improbable that the emission of charged particles from the surface was a factor of primary importance." Those of you who may have followed recent developments of the corpuscular views of electrical action will remember how it has been proved experimentally that incandescent surfaces emit enormous streams of electrons traveling with high velocities, and the actions of these surfaces in promoting combustion may ultimately be found to depend on the fact that they bring about the formation of layers of electrified gas in which chemical changes proceed with extraordinarily high velocity.

The New Processes of Incandescent Surface Combustion.—Leaving now the theoretical aspects of the subject, I will, with your kind permission, proceed to describe, and in some cases to illustrate by experiment also, some of the more important features of the two processes of "incandescent surface combustion," recently evolved at the works of Messrs. Wilson & Mathieson, Ltd., of Leeds, where our experimental station is located. The experiments which I hope to show you were originally designed for lectures which I had the honor of giving at the Royal Institution of Great Britain about 6 months ago, and were subsequently repeated at the recent Glasgow meeting of the Institution of Gas Engineers. They are intended to convey to an audience of technical men a general idea of the wide field of practical utility which we believe lies before the new system; they are necessarily on a small scale, and in nearly all cases the apparatus is merely of a "demonstration" order, in which the rapid illustration of some striking effect is the main consideration.

(a) *General Character and Advantages Claimed.*—The distinguishing and essential feature of the new processes is that a homogeneous explosive mixture of gas and air, in the proper proportions for complete combustion (or with air in slight excess thereof), is caused to burn without flame in contact with a granular incandescent solid, whereby a large proportion of the potential energy of the gas is immediately converted into radiant form. The advantages claimed for the new system are: (1.) The combustion is greatly accelerated by the incandescent surface, and, if so desired, may be concentrated just where the heat is required. (2.) The combustion is perfect with a minimum excess of air. (3.) The attainment of very high temperatures is possible without the aid of elaborate "regenerative" devices; and (4), owing to the large amount of radiant energy developed, transmission of heat from the seat of combustion to the object to be heated is very rapid. These advantages are (as I believe) so uniquely combined in the new system that the resultant heating effect is, for many important purposes, not only preeminently economical but also easy of control.

(b) *Diaphragm Heating and its Applications.*—In the first process the homogeneous mixture of gas and air is allowed to flow under slight pressure through a porous diaphragm of refractory material from a suitable feeding chamber (see Fig. 2) and is caused to burn without flame at the surface of exit which is thereby maintained in a state of red-hot incandescence. The diaphragm is composed of granules of firebrick, bound together into a coherent block by suitable means; the porosity of the diaphragm is graded to suit the particular kind of gas for which it is to be used, but for undiluted coal gas, or coal gas containing only a small proportion of water gas, a diaphragm so porous that the gaseous mixture will readily flow through it at a pressure of ½-inch water gauge is employed. (*At this point such a diaphragm was exhibited.*) The diaphragm is mounted in a suitable casing, the space inclosed between the back oi the casing and the diaphragm constituting a convenient feeding chamber for the gaseous mixture which is introduced at the back. Such a mixture may be obtained in either of two ways, namely: (1) By means of suitable connections through a Y-piece with separate supplies of low pressure gas and air (2 or 3 inches w. g. only is sufficient); or (2), by means of an "injector" arrangement connected with a supply of gas at 2 pounds per square inch pressure; the gas in this case draws in its own air from the atmosphere in sufficient quantity for complete combustion, the proportions of gas and air being easily regulated by a simple device.

To start up a diaphragm, gas is first of all turned on and ignited as it issues at the surface; air is then gradually added until a fully aerated mixture is obtained. The flame soon becomes non-luminous and diminishes in size; then, a moment later, it retreats on to the surface of the diaphragm which at once assumes a bluish appearance; soon, however, the granules at the surface attain an incipient red heat, producing a curious mottled effect; finally, the whole of the surface layer of granules becomes red-hot, and an accelerated "surface combustion" comes into play. All signs of flame disappear, and there remains an intensely glowing surface—a veritable wall of fire but without flame—throwing out a genial, radiant heat which can be steadily maintained for as long as required. My assistant will now start up one of the diaphragms (area 1 square foot) on the table, and you can judge for yourselves both of the quickness of the operation (it takes but a minute or two after starting up to attain full red heat) and of the beauty of the radiant effect produced. No one, I imagine, can see one of those diaphragms in operation and remain a disbeliever in the fact and potency of "Surface Combustion."

Whilst the diaphragm is in operation before you, I may point out some of the more striking features of the phenomenon which it presents. In the first place, the actual combustion is confined within a very thin layer (⅛ inch to ¼ inch, only) immediately below the surface, and no heat is developed in any other part of the apparatus; kindly observe that, whilst the front of the diaphragm is intensely hot, the back of the apparatus is so cold that I can lay my hand on it. In the second place, the combustion of the gas, although confined within such narrow limits, is perfect, for when once the relative proportions of gas and air have been properly adjusted no trace of unburnt gas ever escapes from the surface. Thirdly, the temperature at the surface of the diaphragm can be instantly varied at will by altering the rate of feeding of the gaseous mixture; there is no lag in the temparature response, a circumstance of great importance in operations where a fine regulation of heat is required.

The temperature of a diaphragm working on a coal gas and air mixture, at a given rate of feeding, depends on whether or not the intense radiation from its surface is impeded; with a freely radiating surface the temperature of a properly made diaphragm may be maintained at anything up to about 850° C. (say 1,550° F.) according to the rate of supply of the combustible mixture. Fourthly, a plane diaphragm such as this may be used in any position, *i. e.*, at any desired angle between the horizontal and vertical planes. Fifthly, the diaphragm method is amenable to a variety of combustible gases. Coal or coke oven gas (either undiluted or admixed with water gas), natural gas, petrol-air gas, carburetted water gas are all well suited in cases where unimpeded radiation is required. Also, we have constructed and successfully operated plane diaphragms of all sizes up to 4 square feet in area (2 feet by 2 feet) and are able to vouch from experience that their durability and radiant power are unimpaired even after long continued use.

Incandescent not Dependent on External Atmosphere.—A further important point to which I wish to direct your attention with regard to diaphragm heating is the fact that the incandescence of the surface in no way depends upon the external atmosphere. When once the diaphragm has become incandescent, and the proportions of air and gas supplied in the mixing chamber at the back have been properly adjusted, the surface will maintain its incandescence unimpaired, even in an atmosphere of carbon dioxide.

In order to demonstrate to you this point, we have here a chamber with a glass front which has been filled with carbon dioxide. This lighted taper is, you observe, at once extinguished when plunged into the chamber. My assistant will now plunge into the chamber a small diaphragm which is in a state of brilliant incandescence. (The diaphragm was plunged into the chamber.) You will observe that, although the surface is now surrounded by an atmosphere of carbon dioxide, its incandescence is unaffected.

Application of Diaphragm Heating.—I need hardly point out to you the many obvious purposes to which "Diaphragm heating" may be applied. Grilling, roasting, toasting, are at once suggested; others will doubtless occur to you—such efficient means of attaining radiant heat can hardly fail to find new industrial uses. It will suffice if I demonstrate to you one which has perhaps the charm of novelty, namely, the evaporation and concentration of liquids by means of radiant energy emitted from a diaphragm fixed in a horizontal plane above the surface of the liquid. By means of this diaphragm, mounted so that its incandescent surface is directed downwards, we will now evaporate in this dish a solution of sodium silicate (water glass) an operation it would be impossible to carry out satisfactorily by the ordinary means of heating the vessel by flame from below. By the new method, however, only the topmost layers of the liquid are heated; the radiant energy of the diaphragm is instantly transmitted to the surface of the liquid where it is absorbed and utilized for the evaporation. The sodium silicate separates out as a skin on the surface of the liquid, it is then dried by the radiant heat, and at intervals the crust of dry sodium silicate may be skimmed off. In this way we are not only able to evaporate the solution with a great economy of heat, but we are also able to complete the evaporation of highly concentrated solutions much more easily than by means of heat applied from below.

Incandescent Surface Combustion in a Bed of Refractory Granular Material.—The second process is applicable to all kinds of gaseous or vaporized fuels, and can be adapted to a great variety of both small and large scale industrial heating operations. It consists essentially in injecting, through a suitable orifice at a speed greater than the velocity of back firing, an explosive mixture of gas (or vapor) and air in their combining proportions into a bed of incandescent, granular refractory material, which is disposed around or in proximity to the body to be heated.

I can perhaps best describe the process by the aid of two diagrams showing its applications to the heating of crucible and muffle furnaces. The first slide on the screen (Fig. 3) shows the process as applied to a crucible furnace. The crucible is surrounded by a bed of highly refractory, granular material. The mixture of gas and air is injected at a high velocity through a narrow orifice in the base of the furnace, and as it impinges upon the incandescent bed combustion is instantaneously completed without flame.

The seat of this active surface combustion is in the lowest part of the bed; the burnt gases, rising through the upper layers, rapidly impart their heat to the bed, maintaining it in a high degree of incandescence. The next slide (Fig. 4) shows a similar arrangement for the heating of a muffle furnace, an arrangement which needs no further explanation.

It is obvious that this process is adaptable to many other furnace operations, as, for example, to the heating of retorts, annealing furnaces, and the like. Moreover, it is not essential that the bed of refractory material shall be disposed around the vessel or chamber to be heated; it may be equally well packed into tubes, or the like, traversing the substance or medium to be heated. This latter modification is, as we shall see later, important in relation to the melting of metals or alloys which are fusible at temperatures below about 600° C., and also in relation to steam raising in multitubular boilers. By this process much higher temperatures are attainable with a given gas than by the ordinary methods of flame combustion without a regenerative system; and, as a matter of fact, we have found that with any gas of high calorific intensity (such as coal gas, water gas or natural gas) the upper practicable temperature limit is determined by the refractoriness of the material composing the chamber to be heated (*i. e.*, the muffle or crucible), rather than by the possibilities of the actual combustion itself. When I tell you that in a crucible fired by coal gas on this system we have melted "Segercone" No. 39, which, according to the latest determination of the Reichsanstalt in Berlin, melts at 1,880° C., and also that we can easily melt platinum, you will appreciate the possibilities of the method in regard to high temperatures with gas fired furnaces.

Indeed, at one stage of the investigation, we had considerable difficulty in obtaining materials for the construction of muffles and crucibles which would stand the high temperatures obtainable with coal gas, but we have now succeeded in constructing muffles which will stand temperatures up to 1,400° or 1,500° C. It will also be obvious that the bed of incandescent granular material must be composed of a substance which will not, at the working temperature, exercise a fluxing action upon the walls of the crucible or muffle, or walls of the furnace.

For the very high temperatures obtainable with coal gas, water gas or natural gas, we employ a bed composed either of fragments of magnesia, which has been burned at a high temperature or of a neutral and highly refractory material specially prepared for us. In cases where the temperature required does not exceed 1,200 C. the bed of refractory material may be composed of a good quality of firebrick crushed and meshed to a suitable size.

To start up a furnace, gas is first of all turned on and lighted as it issues from the top of the furnace; the air supply is then gradually opened until the flame strikes back through the granular material and is arrested at the orifices in the base of the furnace through which the explosive mixture enters. The flame raises the granular material in the neighborhood of these orifices to a state of incandescence, after which "surface combustion" quickly supercedes the flame. As soon as the lower regions of the bed have become thorough-

Fig. 1.

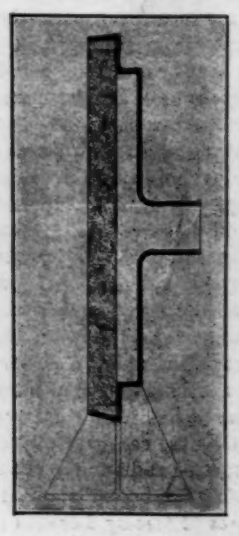

Fig. 2.

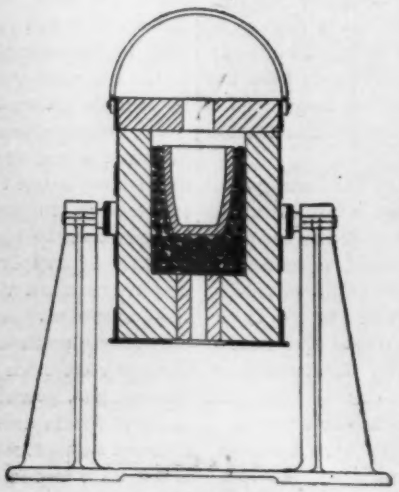

Fig. 3.

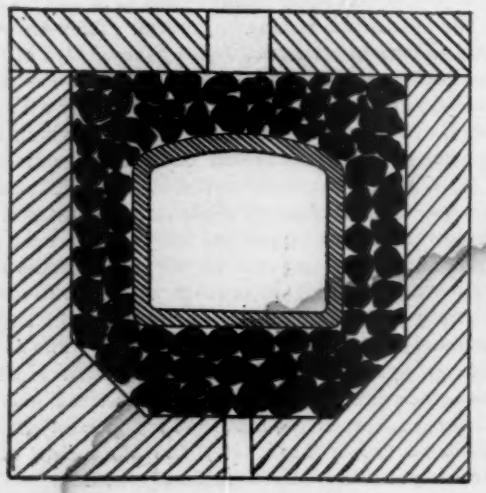

Fig. 4.

ly incandescent, the rate at which the mixture is being fed into the furnace may be materially increased, so that the whole of the lower region of the incandescent bed soon becomes the seat of a very intensive surface combustion.

As I have already stated the method is applicable to all kinds of gaseous and vaporous fuels, but naturally the maximum temperature obtainable in any given case will depend upon the volume and heat capacity of the products for a given heat development in the bed.

Thus, whilst with actual coal gas, water gas, or natural gas, it is possible to attain temperatures of up to at least 2,000° C., with a producer gas of low calorific intensity such as Mond gas, about 1,500° C. would probably be the maximum temperature obtainable without regeneration. With some degree of heat recuperation, which in such a case would be quite practicable, in all probability this limit could be considerably exceeded.

In order to give you some idea of the heating efficiency of this process, I have drawn up in tabular form on the next slide (Fig. 5) the

FIG. 5.—*Results of Test on a Muffle Furnace.* Dimensions of muffle, 9¼ inches by 5¼ inches by 3¼ inches.

Temp. in Middle of Muffle, Deg. C.	Temp. in Middle of Muffle, Deg. F.	Gas Consumption to Maintain Temp. Constant Cubic Feet \ Hour at 15° C.	Temp. of Products. Deg. C.	Temp. of Products. Deg. F.
815	1,499	21.0	540	1,004
1,004	1,840	35.3	645	1,195
1,205	2,201	58.0	870	1,598
1,424	2,596	79.0	1,085	1,985

Mean net cal. val. of gas = 540 B.T.U.'s per cubic foot at 15° C.

results of a test on a muffle furnace in which a muffle 9¼ inches long by 5¼ inches wide by 3¼ inches high (inside dimensions) was heated to temperatures between 815° and 1,425° C., with a fully aërated coal gas of 540 B.T.U.'s (net) per cubic foot. The conditions under which the test was carried out made possible the accurate determination of the rate of gas consumption requisite to maintain the muffle at any constant temperature between 815° and 1,425° C.

The temperatures given in the first two columns are those recorded by a standard thermo-junction placed in the middle of the muffle. The temperature of the escaping products was also ascertained by means of a standard thermo-junction. I particularly want you to observe that the temperature of the products is in every case some 300° to 350° C. lower than that of the muffle, and that even with a muffle temperature of 1,424° C., there was no appearance of flame whatever at the top of the furnace. The gas consumptions recorded in the middle column are extremely economical in comparison with ordinary heating by flame contact. Thus, for example, in a similar test with a muffle of the same size heated by flame contact in a furnace of modern design, the gas consumption to maintain the muffle at 1,055° C. (which was the maximum temperature obtainable) was 105 cubic feet per hour, whereas by interpolation from the above numbers the consumption in the "surface combustion" furnace at the same temperature would have been about 43 cubic feet per hour only.

Surface Combustion as Applied to Steam Raising in Multitubular Boilers.—I now come to a very important application of our process to the raising of steam in multitubular boilers, and to the melting of metals and alloys. I will, first of all, take the subject of steam raising, and by the aid of lantern slides I will endeavor to explain to you the construction and performances of a new type of gas firing boiler in which the principle of surface combustion is utilized.

It is well-known that hitherto the gas firing of steam boilers has not been very successful from the point of view either of thermal efficiency or of rate of evaporation. In this country you have a variety of gases available for steam raising purposes. For example: (1.) Blast-furnace gas (of which there is always a large surplus available from the blast-furnace plants); (2.) the surplus gas which is obtained in the manufacture of coke in by-product ovens; (3.) natural gas of which you have abundant supplies in many localities; and (4.) producer gas of various compositions, but more particularly that manufactured under "ammonia recovery" conditions. All these gases have been found amenable to the system I am about to describe. It has been estimated by a prominent English blast-furnace engineer that the efficiency of the best type of water tube boiler, fired by blast-furnace gas, does not exceed about 55 per cent. From careful observations which were made at my instigation on a battery of Lancashire boilers fired by blast-furnace gas, evaporating water previously softened to within 4° of hardness, with an attachment of the most approved type of economizer (so that the temperature of the burnt gases going to the chimney was reduced to the lowest possible point consistent with good draft) it was proved that the thermal efficiency does not, under the best of conditions, exceed 60 per cent.

With regard to boilers fired by coke oven gas, I think one can safely say that the average thermal efficiency of steam raising does not exceed 65 per cent., and in exceptional cases it may amount to perhaps 70 per cent. It must, therefore, be confessed that the substitution of gas for raw coal in boiler firing has hitherto not been conducive to fuel economy, and indeed in England boilers are rarely gas fired except when there are supplies of "surplus" gases which cannot well be utilized in any other way. But on applying the principle of surface combustion to the gas firing on multitubular boilers, we have been able to obtain results corresponding to the transmission of nearly 95 per cent. of the energy represented by the *net* calorific value of the gas to the water in the boiler. I will now endeavor to explain the construction and mode of operation of the new boiler.

The diagram on the screen (Fig. 6) represents an ordinary multitubular boiler of cylindrical section. It is traversed horizontally by a series of steel tubes, each 3 feet only in length and 3 inches in internal diameter. These tubes are packed throughout their whole length with fragments of a suitable refractory material, meshed to a proper size. Into the front end of the tube, where the gaseous mixture is introduced, is fitted a fireclay plug, through which is bored a circular hole of about ¾-inch diameter. This plug serves a double purpose of keeping the front end of the boiler cool, and of providing a suitable aperture through which the gaseous mixture may be introduced at a speed very much higher than the speed of back-firing.

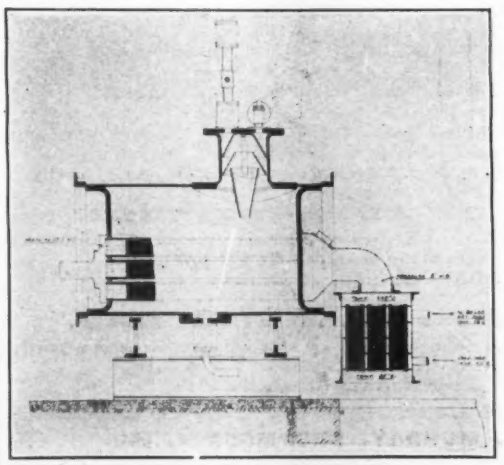

Fig. 6.

Attached to the front plate of the boiler is a mixing chamber of special design. (Not shown in detail on the diagram.) The mixture fed into the boiler tubes from this chamber consists of the combustible gas with a proportion of air very slightly in excess of that required for complete combustion. The mixture is injected or drawn in (either by pressure or by suction), through the orifice in this fireclay plug, on to the incandescent material in the tubes. The combustion of the mixture in contact with the incandescent material is completed before it has traversed a length of about 6 inches from the point of entry to the tube. The result is that the core of the material at this part of the tube is maintained at a high temperature, although the *loci* of actual contact between the hotter material and the walls of the tube are so rapidly cooled by the transmission of heat to the water in the boiler that they never attain a temperature even approaching red heat.

The combustion having been completed, the remainder of the material acts as a baffle toward the burnt gases as they traverse the tubes at a high velocity, causing them to impinge repeatedly on the walls of the tubes. The usual rate at which the gaseous mixture is fed into the boiler corresponds to an hourly consumption of about 100 cubic feet of coal gas *plus* 6 times its volume of air for every tube of the boiler, or an equivalent volume (*i. e.*, equivalent as regards heating capacity) of any other gaseous mixture. Thus in the case of a 10-tube boiler, on which our original experiments were made, the consumption of coal gas was about 1,000 cubic feet per hour plus about 5,500 or 6,000 cubic feet of air. This will convey an idea of the extremely rapid rate at which the mixture is caused to traverse the tubes.

Utilization of the Heat in the Exit Gases.—After the burnt products have traversed the boiler tubes, and at their point of exit therefrom, it is found that their temperature is never more than 70° C. above that of the water in the boiler, which, of course, depends upon the pressure at which the steam is being generated. This is a much lower temperature than that at which the products of combustion usually pass away from a multitubular boiler. But in order to increase still further the output of steam, the products are passed through a short, tubular, feed water heater, constructed on the same

(*Continued on page* 362.)

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BRIEFLY TOLD.

NOVEMBER MEETING, EMPIRE STATE GAS AND ELECTRIC ASSOCIATION.—The first of the sectional meetings of the Empire State Gas and Electric Association for the new association year was held in Syracuse, November 22, 1911, the topic for discussion being "Street Lighting." The Chairman of the Committee on Arrangements (Mr. H. W. Peck, of Rochester) presided at the opening session in the rooms of the Technology Club. The first speaker (Mr. Kennedy of the local Company) welcomed the members and outlined the purpose of the meeting. He was followed by Mr. H. Thurston Owens, of New York city, who described the lighting conditions in the streets of many European cities, and compared them with the newer installations in this country, the talk being fully illustrated by means of stereopticon views. "Construction Work in New York City," by Mr. Dempsey, "White-Way Lighting in Syracuse," by Mr. Dudley, and the "Combination Trolley and Lighting Installation in Poughkeepsie," by Mr. Sherck, completed the morning programme. The fifty-odd members in attendance then enjoyed luncheon at the Hotel Onondaga, after which the business session was resumed. After a few routine matters were disposed of, the installation at Auburn, N. Y., was described by Mr. Reynolds, of that city, who was followed by Mr. Montagnani, of Rochester, who showed the various types of posts and poles used there, especially those made of concrete. "Gas Lighting in Westchester County," by Mr. G. T. Macbeth, closed the formal talks. The meeting was then open for general discussion, the principal points being the difference between European and American practice, large high candle power units being the general practice abroad while the cluster type was more generally used in this country. The use of tungsten lamps on the same circuits as magnetite arcs brought out considerable comment, both pro and con, but no definite suggestion as to the cause for trouble due to excessive loads burning out the tungsten lamps was brought out. The point which came in for the most discussion was that of ornamental versus regular street lighting installations. Very few of the so-called white-way installations are paid for by the city at large, and many were inclined to the belief that the merchants who pay the bill will tire of this method of attracting trade. The advocates of this method felt, should that time arrive, the city would take over the installations and operate same. The fact that these installations give a city considerable prominence at present is sufficient reason for making them. In addition to the members who provided slides, the discussion was entered into by Messrs. Ryan, of Schenectady, N. Y., Macbeth, of Bloomfield, N. J., Durfee, of Rochester, N. Y., Brayton, of Utica, and many others. From the attendance and the interest in the meeting, the method of limiting the meetings to one subject proved a great success, and will likely be continued throughout the season.

THE PANAMA-PACIFIC INTERNATIONAL EXHIBITION.—As our readers know the next extraordinary International Exhibition will be held in San Francisco, in 1915, and although this may seem rather far in advance to move for a bill of particular attention thereto, it in effect is none too soon. The vastness of the scale on which the exhibition is to be arranged calls for width and length of time that in the finality will have been none too great. The West needs the East, the East needs the West; there is neither North nor South in this division. The line round the Globe marking sun-up to sun-down is the median. That the diplomatic work is well underway may be known from the fact that the "Western Governor's Special," is on its trip to the East. Leaving St. Paul, Minn., on the 27th ult., it is due in New York the 11th inst., meanwhile its stops will have been many between the named points. This train will carry the Governors of at least 10 Western States, who will in turn deliver addresses in the cities visited on the importance of the exposition to the entire country. The train will number and include special cars arranged and equipped to show in imposing way samples or exhibits of the products and manufactures of the West, and we are assured by Mr. Van E. Britton that the California car will be a credit to that great center. Mr. Britton also asks us to state that gas men are especially invited to visit the California car wherever the train stops over; the mere notification to the conductor that they are gas men being the signal for their welcome reception and conveying through the train.

ANNUAL MEETING, BOSTON SECTION, NATIONAL COMMERCIAL GAS ASSOCIATION.—The annual meeting of the Boston Section, National Commercial Gas Association, was held in Boston, the evening of Wednesday, November 22. The attendance was both numerous and representative, and interesting addresses were made by Messrs. E. N. Wrightington, W. B. Nichols, L. J. Joyce and A. H. Vegkley. The set piece for the evening was a paper by Mr. R. C. Ware, the subject of which was "Advertising." The paper led to a brisk discussion. The general drift of sentiment was that the work of the Section during the year had been useful to the individual and beneficial to the work in which the individuals were engaged. The officers elected were:

President.—W. B. Nichols, Quincy.
Vice-President.—A. H. Vegkley, Boston.
Secretary-Treasurer.—C. J. Connell, Boston.

While the general programme for the year 1912 has not been altogether completed, nevertheless its providings thus far go to show that there will be little ground for complaint that the Section will in any sense be inactive, either from the viewpoint of usefulness or of fraternality.

NOVEMBER MEETING, PHILADELPHIA SECTION, ILLUMINATING ENGINEERING SOCIETY.—The November meeting of the Philadelphia Section, Illuminating Engineering Society, was held in the Assembly Hall, building of the Philadelphia Electric Company, 1000 Chestnut street, the evening of Friday, the 17th ult. The usual dinner preceding the session was had in "Mosebachs," 929 Market street, and 48 members and guests shared in its pleasures. Dinner over, the party adjourned to the lecture hall to inspect the latest type of incandescent gas lamps on the market, and also a goodly array of appliances connected therewith. Later on these exhibits were explained and demonstrated in lucid way by Mr. R. F. Pierce, of the Welsbach Company. The meeting proper was called to order, at 8 P.M., by the Chairman (Mr. Joseph D. Israel), by which time the number in attendance was close to 200, a goodly percentage of the number being invited guests. The first speaker was Mr. E. J. Brady, whose paper was entitled "A Comment on the Application of Photometric Data to Interior Illumination." Despite its brevity, its paragraphs brought out a very good exchange of thought. The second paper, on "Natural Gas: Its Production and Utilization," was prepared by Mr. George S. Barrows. A year or more ago we had occasion to welcome Mr. Barrows to the ranks of paper preparers, and also to remark that he was of the sort who would make good, if he could be induced to continue. Well, he has equalled the good thoughts we all had about him, for his last communication to the Philadelphia Section archives was listened to with pleasure and will be applied with benefit by many. It was profusely illustrated with well set, well handled lantern slides. Prominent in the ranks of those who discussed both papers were: Prof. Rowland, and Messrs. C. O. Bond, I. N. Knapp and George B. Muth.

CURRENT MENTION—

THIS, from Baltimore, under date of the 23d inst., pleasantly narrates some fraternal amenities: "Eight hundred employees of the Gas Division of the forces of the Consolidated Gas, Electric Light and Power Company, of Baltimore, attended a meeting one evening last month, at the Front street station of the Company, the purpose of which was to inaugurate the season's work concerned in the educational course arranged by the Company. The course is really a continuation of the series of talks delivered by department heads last winter. The meeting was informal and was really planned to afford opportunity for the employees to become better acquainted with each other. Mr. George Beadenkopf, Engineer of the Division, having announced the purpose of the assembling, Mr. Charles M. Cohn, Vice-President of the Company, delivered an address in which he discussed the obligations of a public service company to the community which it serves. The speaker pointed out that, in representing that company, the employee was the corporation in action, and that the public knew and judged the corporation by the manner in which its employees performed their duties. Mr. Cohn dwelt upon the importance of small things. He pointed out most tellingly the opportunities offered by the educational course to improve themselves. 'I can recall,' said he, 'the time when it was the policy of some gas companies not to let their employees know what the company was doing. Now, the policy is to inform the employees, not only of the company's actions, but the reasons for such actions.' Mr. Cohn emphasized the fact that the educational course was in no sense compulsory, but that it was open to all those employees who desired to take advantage of the opportunity it afforded to become acquainted with the methods of the Company in the manufacture, distribution and sale of gas. Mr. Herbert K. Dodson, the Company's Commercial Agent, addressed the meeting, his remarks having chiefly to do with the recent Denver convention of the National Commercial Gas Association. He outlined the work of the convention, and then gave a pithy *resume* of the growth and development of the Baltimore Company. Having reported the great strides taken by the Company in the utilization of gas as a fuel, stress was laid upon the importance of the lighting field. The progress of gas lighting was fittingly dwelt upon, and the efforts of the Company to leave no excuse for poor or indifferent gas lighting were graphically described. An orchestra rendered suitable harmony and added to the zest with which an excellent supper (served directly on the conclusion of the addresses) was enjoyed.—D. N."

MAYOR FITZGERALD, after the manner of men who follow ancient practice in severing "Gordian knots," has ordered the rejection of all bids made some weeks ago for furnishing gas lamps to the city of Boston. New bids will be asked for at once. It may be remembered that the contract called for perhaps 11,000 lamps, and the seemingly lowest bidder at the time, was the United Gas Light and Mfg. Company, of New York. A German concern was another bidder, but that party bid on the price of the lamps in Saar, or somewhere else on German soil. Naturally, this was not free-on shore in Boston. Mayor Fitzgerald further directs that in the new specifications the price submitted must be the price f. o. b. Boston.

MR. A. A. HUSTED (he has been with the Company quite a while) succeeds Mr. Glenn R. Davis as Superintendent of Manufacture and Distribution at Big Rapids, Mich.

THE Public Service Gas Company, of New Jersey, has arranged for the construction of a handsome office building for the accommodation of its patrons in the Bayonne district. It is to be located at the corner of 42d street and Avenue B.

THE Consumers Gas Company, of Toronto, Canada, has agreed to increase the pay of its works' employees. Under the agreement "inside men" are to get $2.40 per day, and "outside men" are to receive $2.10. Heretofore the schedule called for $2.25 and $1 95.

THE Gas Machinery Company, of Cleveland, O., has been awarded a contract for a water gas set and tar extractor, to be constructed for and installed in the generating plant of the municipal gas works, Kingston, Canada. Well, if reciprocity is not ready for the immediate relations of the States and the Canadas, it is nevertheless reassuring to know that reciprocal relations exist between the factors in the gas industry of the two border lands.

THE mention of this contract reminds us of the fact that the Manager of the gas and electric divisions of the business of the Corporation of Kingston (Mr. C. C. Folger), has just been appointed to supervise the water supply of that city, which is also operated on public account. This is certainly pleasant recognition of worth and merit, for of a verity Mr. Folger's course, in his excellent methods of handling the gas and electric systems of Kingston, has proved himself an efficient public servant. We congratulate the corporation on its practical recognition of Mr. Folger's merit, and we congratulate him on the fact that he has earned the unqualified endorsement of his official superiors.

Publications.

[All Publications, Catalogues, etc., mentioned below, are kept in our office for the convenience of our patrons.]

Fourth Annual Report (1910) *Public Service Commission, Second New York District.*—The complete report of the Public Service Commission, Second New York District, is ready for distribution. The Commission supervises all of the gas, electric and street railway properties in New York State, outside of New York city, and the telegraph and telephone companies of the whole State. The number of corporations supervised totals 944, and the cases considered in the various classes concerned in these divisions of their considerings are: Electrical, 301; steam railroad, 184; street railroad, 129; express, 7; sleeping car, 1; coal and water gas, 36; natural gas, 55; acetylene, 30; gasoline, 18; gas and electric, 49; other combinations, 4; telegraph, 10; telephone, 135. The total applications and complaints were 2,059, and the total disposed of during the year numbered 1,685. The public hearings numbered 551. The total expense of the Commission was $295,443.08. The various tests of gas and gas meters are given in detail, as well as the various orders of the Commission. Copies of the report may be obtained upon request.

"*Abstracts*," *October*, 1911. *American Gas Institute.*—The October number of the "Bulletin of Abstracts" published by the American Gas Institute is now ready for distribution. The abstracts are veritable holders of valuable data concerning all phases of gas engineering. They may be obtained for a small outlay by members of the Institute, and should add to the already many and potent reasons for becoming members by those not already enrolled.

Massachusetts Legislation Respecting Lighting Matters.—The Board of Gas and Electric Light Commissioners, of Massachusetts, has issued a pamphlet covering new legislation (1910-11), of especial interest to gas and electric lighting companies. The matter presented should be of interest to managers throughout the country. Further, it is presented in the painstaking way followed by the Commission in all the records that emanate through or by it. Copies may be obtained by addressing the Commission, at the headquarters in Boston.

Physical and Chemical Properties of the Petroleums of San Joaquin Valley.

The United States Bureau of Mines, in following out its investigations into petroleum, has published "Bulletin No. 19," which deals with the "Physical and Chemical Properties of the Petroleums of the San Joaquin (Cal.) Valley." The story is told by Mr. Irving C. Allen and Mr. W. A. Jacobs, and in detailing the investigations which are to be conducted by the Bureau of Mines, the authors say in their introduction:

"Realizing the great importance and wide application of petroleum and its products for fuel, lighting and lubrication, and the absence of authentic and comprehensive information in the literature on the commercial value of American petroleums, the United States Geological Survey has for a number of years been making analyses and other examinations of these oils and their products. In 1907 the technologic branch of the Survey began a study of certain economic problems having to do with the natural mineral oils, the prime object of the investigations being to determine the economic value of the petroleums and natural gases in the United States, with special reference to the supplies in the public lands, and to ascertain how these resources could be utilized in the industries with the least waste and greatest efficiency.

"This work, which is now being conducted by the petroleum section of the Bureau of Mines, under authority of the act of May 16, 1910, will include the collection at the wells and refineries of information as to the following details:

"Facilities for handling and storage at the wells. Facilities for transportation, whether by pipe line, rail or water. Distance to the nearest port or center of industry, and time necessary for delivery. Facilities for storage at such point of delivery. Suitability of the crude oil for fuel, or the treatment necessary to convert it most economically into the best fuel; best processes of refining or of converting the crude oil into its many products; the examination of these products; the utilization of by-products and residues of the refineries; the collection of adequate and reliable samples, and the complete chemical and physical examination of these samples in the laboratory.

"It is hoped here that the information thus obtained will render possible the establishing of suitable specifications for gasolines, kerosenes, certain lubricants and fuel oils. In the near future a study will also be made of the problems involved in the most economical utilization of the heavy crude oils in the various types of internal combustion engines. The gas producer problem, because of its importance, will also be investigated, as a producer capable of converting the heavy oil residues directly and completely into a combustible gas would be of paramount value to the oil industry.

"The art of burning heavy oils under boilers for steam raising has not been developed to its highest efficiency, and a thorough study of this problem also is to be undertaken. This Bulletin is the second report so far published, and deals primarily with the large oil fields of the San Joaquin Valley of California. The work will be continued as rapidly as possible and will include all of the more important petroleum districts in the United States."

(*Continued from page* 359.)

principle as the boiler. During a test carried out at our experimental station in Leeds, in which steam was being generated at a pressure of 100 pounds per square inch above that of the atmosphere, the temperature of the products leaving the boiler tubes was 230° C.—the actual boiling point of the water being 170° C. These products, still containing a certain amount of valuable heat, were passed through the feed water heater (which was only 1 foot long), containing 9 tubes of the same diameter as the tubes in the boiler. Each tube was packed with granular material. The hot products, continually baffled in their passage through the tubes, readily imparted their heat to the cold feed water surrounding them. We were thus able to reduce the temperature of the products leaving the feed water heater to somewhat less than 100° C.

The 10-*Tube Experimental Boiler.*—I will now briefly describe, by the aid of photographs and slides, the construction and performance of the 10-tube boiler, on which we have been experimenting for upwards of a year in Leeds. The connections to the front of the boiler (Fig. 7) consist essentially of a tube for the supply of gas and another for the supply of air.

Fig. 7.

The gas and air are mixed before entering the feeding chamber, which is attached to the front plate of the boiler; the gaseous mixture is burned in the tubes of the boiler; the products pass outwards at the other end into a small chamber, and from thence into the feed water heater. The latter contains 9 tubes, each 1 foot in length and 3 inches diameter, which are filled with granular material to effect the exchange of heat. The second view of the boiler (Fig. 8) shows the end at which the burned gases make their exit.

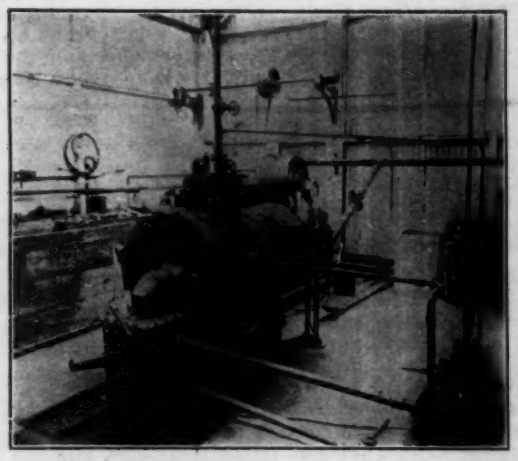


Fig. 8.

Results obtained with the Boiler.—With regard to the results achieved with this boiler, in our experimental station at Armley, there is no coke oven gas or producer gas available; therefore, we have worked entirely on Leeds coal gas. But there is no doubt that, had we been able to use the surplus gas from by-product coke ovens (which has practically the same composition and calorific value as Leeds coal gas), we should have obtained the same results as with the Leeds gas. The mixture of gas and air was passed into the fuel chamber of the boiler at a pressure of 17.3 inches water gauge. This pressure is necessary in order to overcome the resistance of the packing of the tubes to the passage of the gases through them. The pressure of the products entering the tubes of the feed water heater was 2 inches water gauge, so that the pressure necessary to force the gas through the zone of combustion, and thereafter through the remainder of the length of the tubes of the boiler, was about 15 inches water gauge. In carrying out the test, the water was evaporated at a pressure of 100 pounds per square inch above that of the atmosphere; the temperature of the boiling water was, therefore, 168° C., or 337° F. The temperature of the combustion products leaving the boiler tubes was 230° C. The average temperature of the products leaving the feed water heater was 95° C., or 203° F. The temperature of the water entering the feed water heater was 5.5° C., or 42° F., and it was heated to 58° C., or 136.4° F., before entering the boiler, entirely at the expense of the burnt gases.

Let us now consider the heat balance of the boiler during the test. The amount of coal gas fed into the boiler expressed as dry gas at 0° C. and 760 mm., was 996 cubic feet per hour. The net calorific value of the gas was 562 B.T.U.'s per cubic foot, so that the total heat supplied to the boiler, in terms of the net calorific value of the gas, was 559,800 B.T.U.'s per hour.

As to the amount of water evaporated, the following figures apply to the combination of the boiler with its feed-water heater, because the two really comprise one steam raising system. The temperature of the feed water was 5.5° C., and the steam was being raised at a temperature af 100 pounds per square inch above that of the atmosphere. The actual amount of water evaporated was 450.3 pounds per hour, which, in terms of water evaporated from and at 100° C., would be 550 pounds per hour. The actual heat therefrom transmitted to the water was 450.3 × 1,172 = 527,800 B.T.U.'s per hour. The ratio between the heat transmitted to the water and the net heat of combustion of the gas burnt in the boiler, therefore, was 0.943.

It is one of the outstanding merits of the new system that we are able to burn the gas completely with a minimum excess of free oxygen, and during the test in question the average proportion of carbon dioxide in the combustion products was as much as 10.6 per cent. whilst the oxygen was as low as 1.6 per cent. The most careful examination of the products failed to reveal the presence of the slightest trace of CO, H_2 or CH_4. Therefore, the remainder of the gas was simply nitrogen. Even with as little as 0.5 per cent. of oxygen in the products, the combustion of the gas in the tubes is perfect, not a trace of combustible gas escaping.

The 110-*Tube Boiler for Coke Oven Gas.*—That the gas firing of boilers according to the new system has now been advanced beyond the merely experimental stage is proved by the recent erection of a 110-tube boiler, capable of evaporating not less than 5,500 pounds of water per hour, to the order of the Skinningrove Iron Co., Ltd. (the Cleveland District, Yorkshire), to be fired by gas from a new installation of Otto-Hilgenstock by-product ovens adjacent to their blast furnaces. I have brought with me slides (Figs. 9 and 10) made from photographs of the boiler with its feed water heater as erected in the shops of Messrs. Richardson and Westgarth, Middlesbrough, the builders. The boiler itself is a cylindrical drum 10 feet in diameter and only 4 feet from front to back; it is traversed by 110 tubes of 3 inches internal diameter which are packed with fragments of firebrick. The boiler will be worked under the suction of a fan, capable of producing a "suction" of 20 inches water gauge. To the front of the boiler is attached a device whereby gas at 2 inch *w.g.* pressure from a suitable feeding chamber together with a proper proportion of air from the outsine atmosphere, is drawn

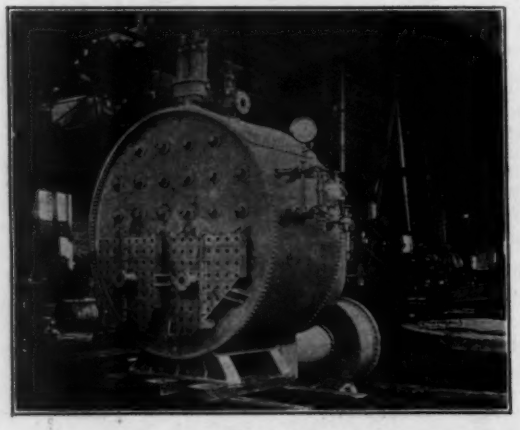


Fig. 9.

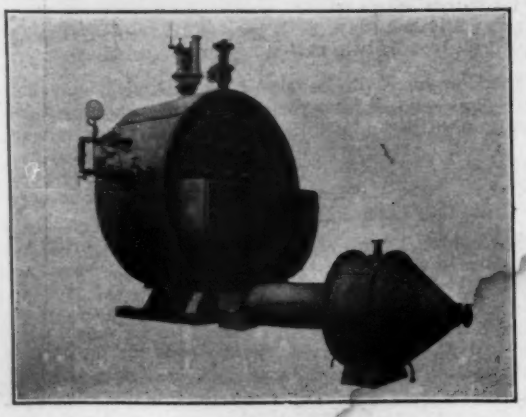


Fig. 10.

(under the suction of the fan) through a short "mixing tube," into each of the 110 tubes of the boiler, where it is burnt without flame in contact with the incandescent granular material. The products of combustion, having traversed the 4 feet length of packed tube, will pass outwards into a semi-circular chamber at the back of the boiler, and thence through a duct to the tubular feed water heater which is depicted in the second photograph. The fan, which is attached to this feed water heater, will suck out the cooled products and discharge them through a short duct into the atmosphere outside the boiler house.

I have perhaps already said enough about the boiler and its working to convince you that it at least gives promise of combining structural simplicity, high thermal efficiency and concentration of power in a degree which is absolutely unique. From the constructional point of view nothing could be simpler or more compact than a cylindrical shell, only 4 feet long by 10 feet in diameter, supported on a casting and requiring neither elaborate brickwork setting nor chimney. It has the further structural advantage over all other multitubular boilers in that the front plate can never be heated beyond the temperature of the water, however much the firing may be forced, a circumstance which, coupled with the extremely short length of the tubes, implies an absence of strain and greatly reduces the risk of leaky joints. Another feature of the boiler, which makes for efficiency, is the steep "*evaporation gradient*" along the tubes. Under the normal working condition, the "*mean evaporation*" exceeds 20 pounds per square foot of heating surface, or about twice that of a locomotive boiler. Of the total evaporation no less than 70 per cent. occurs over the first part length of the tubes, 22 per cent. over the next part and about 8 per cent. over the third part. Such a steep gradient causes a considerable natural circulation of the water in the boiler, a factor of great importance from the point of view of good working. In regard to thermal efficiency I venture to claim that a boiler unit which, whilst evaporating 20 pounds of water per square foot of heating surface, transmits upwards of 90 per cent. of the net heat of combustion of the gas to the water, and which if need be, can be forced to a 50 per cent. higher "duty" with only a slight drop in efficiency, stands unrivaled as a steam raiser. Moreover, in the case of a large boiler of (say) 100 tubes, "elasticity" may be conferred by arranging the tubes in groups so that they may be either fired up or conversely shut off, group by group, successively, in correspondence with variations in the load. Indeed, I want no more practical demonstration of the validity of my views on "surface combustion" than this boiler.

The Melting of Easily Fusible Metals and Alloys.—It will be readily understood that the principle embodied in the boiler is capable of great extension. Thus, for example:

(1.) The preliminary concentration of dilute solutions and the heating of liquids generally; (2), the heating of large volumes of air; and (3), the melting of easily fusible metals and alloys.

Unfortunately, time does not permit of my dealing with these further applications in every detail. I should like, however, to refer briefly to the results of our experiments upon the fusion of metals. Our attention was first drawn to this subject by one of the London gas companies, who represented to us that there would be a large field of usefulness for our process in the melting of type metal for newspaper purposes. The printing of a newspaper of large circulation necessitates a continuous supply of molten type metal, and we are reliably informed that several of the leading London newspapers require 20 tons of molten type metal continuously at hand during 16 out of the 24 hours. In the experiments which I now propose to describe to you, lead has been used instead of type metal, but the method is applicable to all metals or alloys whose fusion points lie below about 600° C. The diagram (Fig. 11) on the screen represents an iron tank, efficiently lagged and filled to the top with molten lead at a temperature some 50° or thereabouts above its melting point. In the molten bath is fixed an iron tube, some 2 or 3 feet in length and of 3 inches internal diameter. This tube is packed (like one the boiler tubes) with a suitable granular, refractory material, and there are suitable arrangements for the introduction of the explosive mixture of gas and air which is to be burned in the tube. When once the device has been started up it will work continuously for days together. Solid lead is continuously fed into the apparatus and the molten metal is allowed to run over through the spout indicated in the diagram. For the sake of simplicity I have described and illustrated a small tank fitted with one combustion tube, but experiments have been carried out with tanks holding up to 8 tons or more of molten metal in which the series of combustion tubes are fixed. By the means of such an apparatus, lead (or other fusible metals or alloys) may be melted not only very rapidly, but with extraordinary efficiency, and as an example of this, I will quote the results of a test carried out at our experimental station with a single tube apparatus. These may be conveniently tabulated as follows:

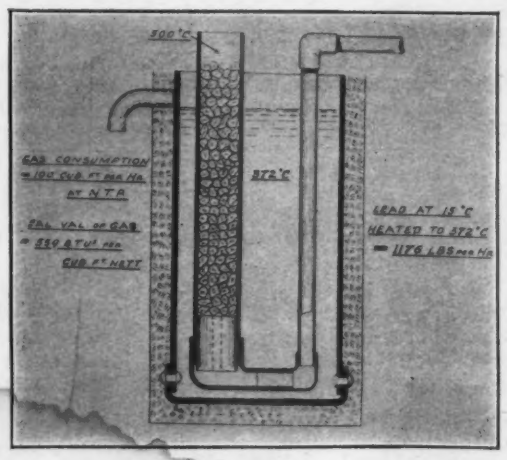


Fig. 11.

FIG. 12.—*Lead Melting Test.*

	Degs. C.	Degs F.
Temp. of metal charged	15	60
Temp. of metal tapped	372	682
Temp. of gas leaving apparatus	500	932

Lead melted per hour = 1,176 pounds.

Heat required per hour to raise metal from 15° C. to 372° C. = 1,176 × 32.67 = 38,420 B.T.T.

Gas burnt per hour = 100 cubic feet at N.T.P.

Net. cal. val. of gas = 559 B.T.U. per cu. ft. at N.T.U.

$$\text{Ratio} = \frac{38,420}{55,900} = 0.686$$

The conditions of the test were so arranged that the mean temperature of the molten metal in the apparatus (as ascertained by a thermojunction) was 372° C., throughout the test. Lead ingots, each weighing about 30 pounds, were added at intervals of 1½ minutes; the molten metal displaced was simultaneously run off into moulds. Great care was taken to keep the bath thoroughly molten and at a temperature within a few degrees of the mean value. Burning gas, of net calorific value 559 B.T.U.'s per cubic foot, at the rate of 100 cubic feet per hour, it was found possible to raise the temperature of 1,176 pounds of lead per hour from 15° to 372° C., the temperature of the products of combustion leaving the tube keeping constant at 500° C., or only 128° above the temperature of the molten metal. From the latest determination by Spring of the specific heat of lead at temperatures up to and above its melting point, and adopting the usually accepted value for the latent heat of fusion of lead, I calculate that the heat required to raise the temperature of 1 pound of lead from 15° C. to 372° C. (including melting) is 32.67 B.T.U.'s. Therefore, the heat transmitted to the lead per hour during the experiment was 1,176 × 32.67 = 38,420 B.T.U.'s, whereas the *net* calorific value of the gas burnt per hour was 55,900 B.T.U.'s the ratio $\frac{38,420}{55,900} = 0.686$.

Inasmuch, however, as the *net* heat of combustion of the gas is based on the assumption that the products of combustion (less steam) are cooled down to 15° C., whereas in the experiment the temperature of the molten metal was 372° C., it follows that the high ratio of 0.686 does not do full justice to the merits of the system. Under "ideal" conditions the temperature of the gases leaving the combustion tube could not have been reduced below 372° C., they were actually reduced to within 130° of this "ideal" temperature. Taking these circumstances into consideration, I calculate that the "efficiency" of the melting operations was practically 80 per cent. of that which could have been achieved under ideal conditions. The balance of 20 per cent. would be made up of (1) heat carried off in the waste gases which, under ideal conditions, might have been utilized; and (2) radiation losses.

Having concluded the formal part of my lecture, and before the further experimental demonstration is resumed, I wish to express my great obligation to the authorities of the University of Leeds and of the Imperial College of Science and Technology, in London, for granting me leave of absence from my teaching duties and engagements in order that I might appear before you to-day. The University of Leeds has recently formed a very close association with the coal gas industry in Great Britain, and the endowment of the chair which I have the honor of occupying at Leeds University, in memory of the late Sir George Livesey, is the sign and seal of this alliance.

We, of the Leeds University, attach great importance to the organization and development of its departments of Applied Science, and I am authorized by my friend, Prof. Smithells, our Pro-Vice Chancellor and Dean of the Faculty of Science, whose researches on the structure and chemistry of flames are familiar to all gas engineers, to convey to the American Gas Institute cordial greetings from the University of Leeds.

[Continued from page 348.]

Actual Leakage in Unaccounted-for Gas.

[Prepared by MR. JACOB D. VON MAUR, for the Sixth Meeting, American Gas Institute.]

Actual Leakages.—Having made all possible correction as to temperature, moisture, pressure, etc., at the works, and taking due account of the condensation, etc., taken from the drips, the unaccounted-for gas will then be made up of the following items:

CLASS A.

1. Leaks at lead joints.
2. Leaks at cement joints.
3. Broken mains.
4. Split pipe or bells.
5. Loss of gas at time of making main connection.
6. Leaks due to electrolysis.
7. Leaks through walls of pipe.

CLASS B.—(*Leaks at Service Pipes*).

1. Services rusted through corrosion.

2. Services eaten out by electrolysis.
3. Broken or split fittings.
4. Leaks at stopcock.
5. Gas escaping at time of making service connection.
6. Service broken.
7. Split pipe.
8. Services pulled out of main.
9. Leaks at meter or meter connections.

CLASS C.—(*Leaks at Street Lamps*).

1. Too early lighting.
2. Too late extinguishing.
3. Excessive consumption of burners over requirements.
4. Broken lamp posts, causing services to leak.
5. Leaks caused by similar conditions to Class B.
6. Leakage of pilot lights.

CLASS D.

1. False connections by-passing meters.
2. Slow meters.
3. D. R. meters.
4. Losses due to temperature effects.

When gas is compressed after having been measured at the station meter, and then allowed to expand through street regulating stations, etc., there will be an additional loss, due to water and hydrocarbon vapors being condensed out of the gas during compression. This liquid is pumped from the high pressure mains, and so is lost to measurement, except such portion as was allowed for in the original correction for temperature and moisture.

Bottle-Tight Mains.—Your Chairman of the Technical Committee asked me to discuss particularly the question of "Bottle-Tight Mains." It is not a particularly difficult matter to install a system of practi cally bottle-tight mains; the trouble arises in keeping them so. Before we go too far into the question, however, it will be profitable to examine our standard system to ascertain just how nearly bottle-tight it is or can be made, either in methods or materials, in order to reach a higher degree of perfection. By the standard system of main is meant ordinary, cast iron, bell-and-spigot pipes, laid with either lead or cement joints; and, for illustrative purposes, the system in St. Louis may be taken as a fair example.

During the past few years a very accurate report was kept of every leak which had been reported in that city, but it must be understood that this does not take into consideration leaks that have been found due to electrolysis or corrosion, etc , while actually rehabilitating an entire street—as, for instance, ahead of paving work—but refers to reported leaks only. It so happens that the greater portion of the soil in St. Louit is a yellow clay, which in its undisturbed condition is very nearly gas-tight. We have, therefore, found in our overhauling work many cases of services, etc., eaten out by corrosion or electrolysis, which in less favorable soils would have manifested themselves long before they were actually discovered.

Prior to the year 1903, the distribution system was in a very bad condition and necessitated a vast amount of overhauling and new work. A distinction has, therefore, been made in the following tables, showing the total amount of leaks of each class for the entire period of 30 months prior to January 1, 1911.

1. On work done prior to January 1, 1903—called "Old work." 2. On work done subsequent to January 1, 1903—called "New Work."

TABLE 3.—*Broken Mains: New Work.*

No. of Break.	Size, Inches.	Where Broken.
One	3	At service.
One	3	By contractor.
One	3	Unknown.
Two	4 bells	"
Six	4 mains	"
Three	4 "	By sewer.
Eleven	4 "	At service.
One	6 "	By sewer.
One	6 "	At service.
Two	6 "	Unknown.

No breaks were reported in mains of the following sizes, in inches: 16, 20, 24, 30.

TABLE 4.—*Broken Mains: Old Work.*

No. of Break.	Size, Inches.	Where Broken.
Twenty-eight	3 mains	Unknown.
Five	3 "	At service.
One	3 split sleeve	Unknown.
Twenty-seven	4 mains	"
Eight	4 "	At service.
One	4 sleeve	Unknown.
One	4 bell	"
One	6 "	"
One	6 main	By graders.
Eight	6 "	Unknown.
One	6 "	By sewer.
One	8 "	Electrolysis.
One	8 "	Unknown.
Four	10 "	"
One	10 bell	"

No breaks were reported in mains of the following sizes, in inches: 12, 16, 20, 24, 30.

TABLE NO. 5.—*Leaking Joints: New Work.*

Size, Inches.	Where Broken.
One 3	Cement joint.
Two 3	Lead joints.
Five 4	Cement joints.
Thirteen 4	Lead joints.
One 6	Cement joint.
Eleven 6	Lead joints.
No 8 inch cement.	
No 10-inch cement.	
No 10-inch lead.	
One 12	Cement joint.
Eleven 12	Lead joints.
Twenty one 16	Cement, high pressure.
Seventy-seven 16	Lead, high pressure.
No 20-inch high pressure, cement.	
No 20-inch high pressure, lead.	
No 20 inch low pressure, cement.	
No 20-inch low pressure, lead.	
No 24-inch low pressure, lead.	
Eighty-seven 24-inch high pressure, cement.	
Six 24-inch high pressure, lead.	
No 30-inch cement or lead.	

TABLE NO. 6.—*Leaking Joints: Old Work.*

(1) 3-inch, cement.	(130) 10-inch, lead.
(6) 3-inch, lead.	No 12-inch, cement.
No 4-inch cement.	(10) 12-inch, lead.
(7) 4-inch, lead.	No 16-inch, cement.
No 6-inch, cement.	No 16-inch, lead.
(2) 6-inch, lead.	No 20-inch, cement.
No 8-inch, cement.	No 20-inch, lead.
(26) 8-inch lead.	No 30-inch, cement.
No 10 inch cement.	No 30-inch, lead.

TABLE NO. 7.—*Service Laaks: New Work.*

(90) Broken by graders.
(1) Broken by Water Department.
(4) Broken by sewer.
(14) Broken by main.
(1) Pulled out at main.
(1) Leaking drip riser.
(61) Leaking at stopcock (caused by wagons driving over stop boxes).
(2) Leaking at service header.
(2) Leaking in coal chutes.
(9) Leaking at lamp burners.
(118) Eaten out by electrolysis and corrosion.
(6) Leaking at fittings.
(3) Leaking at sand holes in fittings.
(4) Pipes split.
(146) Broken, caused by lamp posts being struck by vehicles.

TABLE NO. 8.—(*Service Leaks÷Old Work*).

(45) Broken by grader.
None broken by Water Dept.
(3) Broken by sewer.
(4) Broken at main.
(2) Broken (cause unknown).
(25) Services leaking at cock.
(250) Services eaten out by electrolysis and corrosion.
(38) Defective fittings.
(3) Leaking in coal chutes.
(2) Leaking at service headers.
(1) Leaking in sand hole at fitting.
(2) Leaks at valve stems.
(81) Services broken (caused by lamp posts being struck by vehicles).

TABLE NO. 9.—*Total Mileage of Mains.* (*Approximate.*)

	Size Inches	1903	1911
Under	3	12	7.54
"	3	100	73.60
"	4	211	394 23
"	6	91	210.74
"	8	25	24.83
"	10	24	33.92
"	12	21	58.52
"	16	10	20.53
"	20	8	12.17
"	24	4	26.36
"	30	.3	1.14
	Total	506.3	863.58

Referring to Table No. 9 it will be noticed that the amount of new work is about equal to 70 per cent. of the amount of the old work, or approximately 41 per cent. of the total. In addition to this a large portion of the old work has been rehabilitated during the past 8 years. About 80 per cent. of all the mains installed were laid with cement joints, and of late years practically all of the joints have been made with cement.

Discussion of Tables Nos. 3 to 8 Inc'usive.—Referring to Table 3 it will be noticed that there is very little danger from broken mains 6 inches and over in diameter when properly laid.

Referring to table 4, it is evident that the trouble from broken mains is almost entirely confined to the sizes 4 inches and under. As a mat-

ter of fact, in the years 1903 and 1904 we had as many as 30 3-inch broken mains in the single month of January. The deduction to be drawn, therefore, from Tables 3 and 4 is that, if the main system is made up of cast iron bell and spigot joints, from 6 inches to 30 inches diameter, there is practically very little danger of leakage from broken mains, and consequent leakage of gas due to this source.

Referring to Tables 5 and 6, it is very apparent that low pressure mains of all sizes from 4 inches upward can be laid with practically no risk of excessive leakage, if the mains are properly laid and the joints properly made with cement. Even with lead joints the leakage is not as great as is ordinarily supposed. Sometimes a general condition will cause an entire line to leak at the joints. This is illustrated in Table 6, where (130) 10-inch lead joints were found leaking. This main was laid many years ago, and was found to have from 24 inches to 30 inches of cover, and located directly under a rail of a street car track.

The lesson to be learned is that great care should be exercised in selecting the proper location for gas mains. If there are street car tracks on the street there should be a main on each side of the street as near to the curb as possible.

When we come to medium high pressure mains—that is, those operated at 3 to 5 pounds pressure - we find some trouble with leaking joints.

In the case of the 16 inch joints in Table 5, will say that the high pressure main was laid under very bad soil conditions, alongside of a street car track, and parallel to a large water main, and never showed any leaks for 2 years. A sewer was then constructed through the solid rock to a depth of from 10 to 20 feet, alongside of this 16-inch high pressure main. It is only fair, therefore, to consider the leaks on this line to be caused by exceptional circumstances, The main laid on the part of the street on which no sewers have been constructed has remained absolutely tight.

In the case of the 24 inch high pressure mains, shown in Table 5, would say that all of these leaks were found on mains after being laid about 6 months. Not a single leak developed on tests for the entire distance of 4 miles. The main was tested from 10 to 50 pounds, the higher pressure being used occasionally in order to ascertain just how well the work was being done. Every pipe was laid on countersunk blocks, so that the cause of the leaks was either due to contraction or expansion, or to an inferior grade of cement for this purpose. From comparison with other work done we feel satisfied that the trouble in this case was due to the latter cause.

The deductions to be drawn from Tables 5 and 6 are that it is possible to make iron pipe, low pressure system, practically bottle-tight, as far as the joints are concerned, provided the joints are made with cement, and no size less than 6 inches utilized.

If there is any considerable amount of high pressure mains laid with diameters above 16 inches, then there is still some doubt as to the possibility of making these mains absolutely bottle-tight. Certainly they can be made as tight as where the joints are made with lead, possibly more so. Should the writer be called upon in the future to lay any large size, high pressure, cast iron mains, he will probably recommend that the joints be made with cement in the usual manner, and, while the cement is still damp, apply a leak clamp to the joint as an additional precaution. We have repaired leaking cement joints on the large mains by cutting out about 2 inches of the cement, then recaulking the joint with lead. Thus far we have found this to be satisfactory, but cannot say that it would be satisfactory if applied to an entire line of main, although it presents possibilities. The extra expense is warranted, as it costs from $10 to $15 per joint to repair a 24 inch leaking, high pressure joint where the main is laid under an expensive pavement.

In order to bear out some of the above statements I am quoting from Mr. Walton Forstall's discussion of Mr. Simpson's paper before the American Gas Institute last year:

The practice of using cement instead of lead for small pipe was begun in 1900, and, in 1902, extended to all sizes. From the beginning a careful record was kept of all leaks found in cement joints, because it was thought important to know exactly what success or failure was met with. The results at the end of 1909 are as follows:

Size of Pipe.	Feet Laid.	Leaky Joints.
4-inch	105,124	7
6- "	1,333,953	25
8- "	49,891	3
12- "	59,867	19
16- "	33,687	54
20- "	51,833	99
30- "	20,521	332

From the above table it can be seen how nearly bottle-tight a main system can be made where cement is utilized and the work properly done. The table also illustrates how much more difficult it is to make the larger size joints gas-tight.

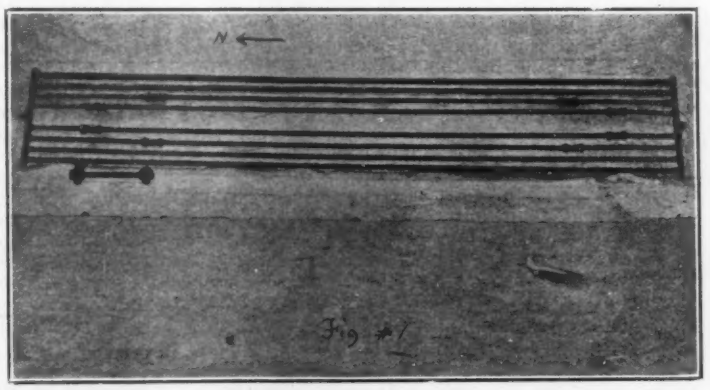
Lead Wool.—The writer had intended to add some data on joints made with lead wool, but it was thought best to leave this matter to be brought out in the discussion. Certain it is that lead wool joints on low pressure mains can be made tight, although at a very much increased expense over other materials. As to high pressure joints on large sized mains, the writer has not been able to gather any data.

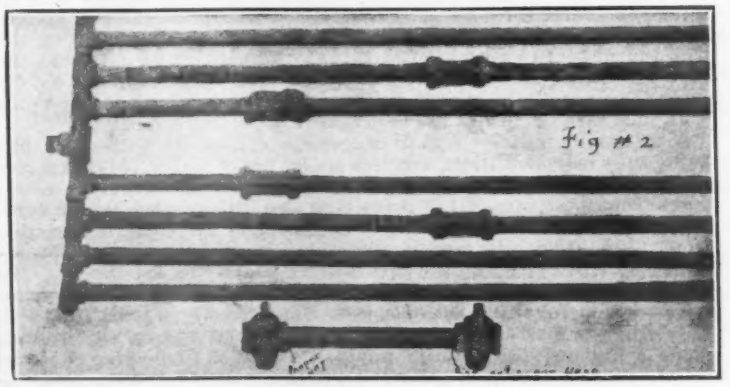
Before leaving the subject of joints, it will be interesting to consider for a moment the practice of "Barring for Leaks." This practice will only show the existence of leaks of considerable magnitude. If the soil is one that does not very readily allow gas to pass through it, then the bar-hole will not disclose the presence of very small leaks. On the other hand, if the soil is of a gravelly nature, or one that will conduct the gas away freely, the results will be even more misleading. The practice has its advantages, but it is not safe to assume that a main is tight, simply because barring over the joints has not disclosed leaks. In general, then, we must look for the greater actual leakage beyond the cast iron system.

Referring to Tables 7 and 8, we can see at once, from the very much larger number of leaks, both in old and new work, and also the larger number of causes which can contribute to a service leak, that the bulk of the leakage lies in the service pipe system. From both tables we note the large number of services broken by contractors grading streets about to be paved. A large portion of this could have been avoided had the mains been laid to proper depths, and the lesson to be learned is that gas companies should insist on not laying mains, except where the street is graded, so that the mains can be laid to proper grade. If there is some urgent reason for doing otherwise, then a correct profile should first be obtained, in order to avoid future expense. Both tables show a large number of leaks at the stopcocks. Practically all of these leaks are due to the fact that the streets on which the leaks developed were uncurbed, so that the wagons passing over the stopbox crush down the service box on the service, causing the leak. The stopcocks used in St. Louis are made with a cast iron body, with brass plug and washer, and although they have been in use for a number of years, we have on record practically no case where a leak has occurred in one of these cocks in ordinary service. It is very difficult to prevent this class of leaks on unpaved streets, but it is suggested that around the stopbox small pieces of flag stone be placed so as to relieve the stopbox of as much strain as possible. Services will always be broken by contractors working on the street, and there is no remedy except that of vigilance. Defective fittings and pipe form a large portion of the leaks in both tables. A careful inspection will reduce this number to a minimum.

Broken and leaking services, caused by lamp posts being broken by passing vehicles, stand out prominently in both tables. There is no way of preventing this, and it is our system to collect damages from the responsible parties, wherever the responsibility can be fixed.

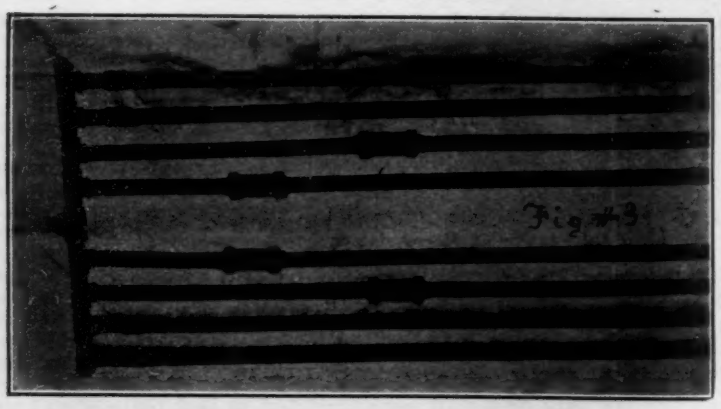
The item of "rusted out" or "corroded" services has always been a very large one, and, in the opinion of the writer, this can never be entirely prevented, but the damage can be much lessened by properly coating the pipe. In St. Louis the practice is to coat all service pipe laid on streets where we have reason to suspect excessive corrosion, and this practice will probably be extended to all service pipes laid in the future, provided experience shows that the covering adopted, or some other to be developed, proves to be satisfactory. The coating is known as "Nicholls' coating" (named after one of the Superintendents), and is made up by covering the pipe with alternate layers of hot pitch, or other suitable compound, paper being wound spirally on the pipe. Up to a certain limit the effectiveness of the coating can be increased by increasing the number of coats of paper and pitch, but for ordinary purposes 4 coats will be found to give vey satisfactory results against ordinary corrosion. The cost of this coating is about 1.1 cents per foot. In order to demonstrate the value of this covering a manifold of pipe was made up, as shown in Figs. 1, 2 and





3. The pipe leading from the main to the manifold is covered pipe and passed under two street car tracks. As shown in Fig. 4, the manifold is made up as follows:

One 12-foot length uncoated pipe, wrought iron; one 12-foot length



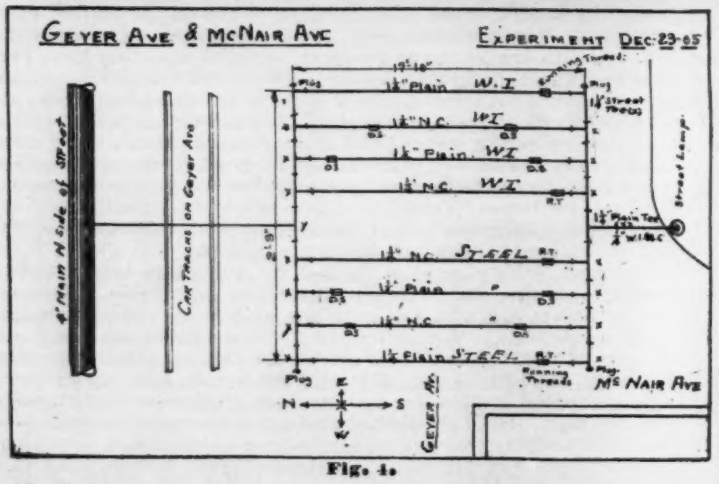


Fig. 4.

coated pipe, wrought iron; one 12,foot length uncoated pipe, steel; one 12-foot length coated pipe, steel; one 12-foot length uncoated pipe, with Dresser coupling, wrought iron; one 12-foot length coated pipe, with Dresser coupling, wrought iron; one 12-foot length uncoated pipe, with Dresser coupling, steel; one 12-foot length coated pipe, with Dresser coupling, steel.

This manifold was installed (as shown), in December, 1905, and was removed March, 1911, being, therefore, in the ground for a period of 5 years and 3 months.

Fig. 1 shows the manifold complete, the left of the figure corresponding to the north. Fig. 4 shows the relative position of a main, manifold and street car tracks. Figure 2 shows the north half of the manifold, therefore, the part nearest to the tracks. Figure 3 shows the south half of the manifold, therefore, the part farthest from the tracks. The pipe leading from the gas main to the manifold, therefore passing directly under the street car tracks, was also covered with the paper covering, and is still in practically perfect condition.

One-half of each pipe has been cleaned and the covering removed, whereas the other half has not been disturbed. The manifold is now on exhibition for inspection by those members who wish to examine it. It will be noted that, in every case, the coated pipe is in practically perfect condition. The street on which this experiment was made was one on which a power house of the street railway company was located, and one on which the damage from electrolysis was probably the greatest in the city; but about a year after the manifold was installed the power house was abandoned and the electrolytic conditions entirely changed. This manifold will be referred to again under the head of "Wrought *vs.* Steel Pipe," but for the present it is sufficient to note that the paper covered pipe has given excellent results. It might be noted that this same coating was tested by Mr. Harper, of Chicago, together with some other 90 coatings of various kinds, and came through all of its tests with practically a perfect record. The result of these tests has already been published in the Gas Journals of October, 1909. It is also interesting to note that the pipe on which the insulated couplings were placed suffered by far more than any of the others, although in the case of the covered pipe with insulated couplings the pipe is still in perfect condition.

Next, taking up the question of leakage caused by split pipe, split bells, split service fittings, services pulled out of mains, leaks at meter connections, etc., it will probably be impossible to entirely prevent leaks from these causes, but if the pipe and fittings used are of sufficient strength, and are properly inspected and installed, the trouble from this cause can be largely eliminated, and this can only be attained by willingness on the part of the company to pay the bill. In large cities 50 to 60 per cent. of the time of inspection and supervision is wasted in travelling between jobs. The remedy is to be found in providing the most modern means for the men to get over the ground. Some companies are waking up to the need of furnishing those in active, general charge of the work with the means to accomplish the best results, but much is still to be desired. The benefit to be derived lies in the future, whereas the pay of the men, and the cost and maintenance of equipment, are in the present. This is the stumbling block that has done more to hold back intelligent progress in distribution work than any other factor I know of. The inspector or general foreman is only of value while actually on the job, and is of practically of no use while traveling between jobs.

(To be Continued.)

Items of Interest
FROM VARIOUS LOCALITIES.

MR. JAMES T. LYNN, accompanied by two Detroiters of prominence, left that city a fortnight or so ago, for a trip virtually around the world. The journey takes them Westward, and their first stopping place will be Honolulu. The party will not return home until June. Meanwhile we avowedly wish that not a dull day will find place in the listings of their itinerary. Certainly, not a day of that sort will be recorded, if "Jim" maintains his customary physical and mental activity.

MR. H. H. HYDE, since 1909 in managerial charge of the H. M. Byllesby & Co.'s gas properties at Tacoma, Wash., has been recalled to the Chicago headquarters of the named firm, to take prominent place in its operating department. Mr. Elmer Dover, heretofore Assistant Manager of the Byllesby Company's Western offices, with headquarters in Portland, Ore., will assume charge of the Tacoma branch. These changes became effective the 1st inst.

A REFERENCE to our advertising columns will show that Messrs. A. B. Leach & Co., with headquarters in No. 149 Broadway, New York city, that this responsible firm has secured control of the capital stock of the newly reorganized Macon (Ga.) Gas Company. The trade is made on the basis of $120 per share for the common stock and $100 per share for the second preferred. Mr. Stuart Wood, Treasurer of the Macon Company, represents the latter's executives in the bargaining, and he invites all holders of the named securities, not directly represented in the original transaction, to turn over the same to Messrs. A. B. Leach & Company, who will pay therefor equal prices to those given to Mr. Stuart and his associates. The owners of the original Macon Company, no matter how big or how fervently they may thank Mr. Wood and Mr. Boardman for their services, covering a period of many years, intricate searchings, definings and adjustings, can never sufficiently requite them. Prim order was brought out of seemingly interminable chaos, a result solely due to an expenditure of much labor and a great dispensing of tact, diplomacy and continued work. Further, through it all, honor was the the impelling controller, and now all are coming into their own.

MR. GLENN R. DAVIS, for 15 years or so connected with the Grand Rapids (Mich.) Company, has been appointed General Manager of the Big Rapids (Mich.) Gas Company.

THE New Business Department of the East Ohio Gas Company, the Cleveland end of which is in charge of Mr. Frank B. Hutchinson, has just completed an extended demonstration of "Paper Bag Cookery and Cooking," which was a tremendous success; meaning that the demonstrations were attended by thousands. Further, that not a hitch marred the exhibition. Those who care to go into the details of the Cleveland show in any aspect should purchase the Cleveland *Plain Dealer*, dated Nov. 18th.

THE authorities of East St. Louis, Ills., have flatly refused to pay bills submitted by the St. Clair County Gas and Electric Company on account of meter rentals charged in times or periods where no gas whatever was used. This is in accordance with the ordinance passed mid-February of this year, which abolished all minimum charges and penalties favored by public service corporations.

THESE advices are from Battle Creek, Mich., under date of Nov. 25, forwarded by "T. J. B.:" Last week an agreement was reached for 90-cent gas, the result of a conference between Attorney George W. Meacham, representing the Battle Creek Gas Company, Mayor Thos. Zelinski and City Attorney D. C. Salisbury, that virtually all the concessions asked for by the city would be granted. The old rate was $1.15 per 1,000, less 10 per cent. on accounts settled within 10 days; the new rate is 90 cents, straight. In 1922 the rate is to be revised by an arbitration committee, and the city reserves the right to buy the gas plant, if desired, the sum therefor to be determined through an appraisal by entirely disinterested parties.

"M. B. S.," writing from Los Angeles, Cal., under date of Nov. 20, says: Dear JOURNAL.—Attacking the constitutionality of the city ordinance which fixes the gas rates to be charged gas users in Los Angeles, the promised suit of the Economic Gas Company to prevent the Board of Public Utilities from interfering with its plan to give discounts to customers who pay their bills at the Company's office was filed last week, in the Superior Court. Two provisions of ordinance No. 22,947 are deemed pertinent to the case, and on these the attack as to their legality was based. The provisions relate to the powers of the Board of Utilities to fix rates, and to the latter as well. The suit sprung from the attempt of the Company to give a discount of 6¼ per cent. to consumers who call at its offices each month to pay their bills, a method, according to the complaint, which means a saving to the Company of $200 a month, which otherwise would have to be paid to collectors. The discount will, it is asserted, mean a large decrease in the number of uncollected bills, and the plan, therefore, would be advantageous to both sides. It is contended that the giving of the discount is not a violation of the ordinance, even should that law be upheld, because the cheapening of gas bills in this manner is not a change of rates as established by the Council. The rate established by the ordinance is 80 cents per 1,000 cubic feet.

MR. L. M. BAINS, writing from Harrisburg, Pa., under date of Nov. 24th, says that on Monday, November 6th the Council of Langhorne Manor granted a final franchise to the Bucks County (Pa.) Public Service Company. The latter's buildings and structures, including a gasholder located at the Langhorne "Cut Off," begin to loom up and form a particularly new feature in the landscape. The mains have all been completed at and between Langhorne and Newtown, and service connections are now being made in this section. The Company's mains have been extended to Yardley, and are now being laid between Yardley and Morrisville, the expectation being that the latter place would be on the line by Thanksgiving Day. The Company further has decided to run its lines to Hulmerville, and hope that that run will be completed before frost puts a stop to all pipe laying operation.

MANAGER LARRABEE, of the Consolidated Lighting Company, Montpelier, Vt., declares there is no truth whatever in the rumor that this property is to be sold to Philadelphia capitalists. The controlling interest in this corporation is held by the Davidson family, Port Huron, Mich. The attorney for it is Mr. Clarence H. Seater.

MR. S. M. GOODMAN, as Trustee for the bondholders, qualified before Referee Hawes, and the plant at Hamilton, O., will be under his direction until the reorganization is perfected. He is bonded in $10,000.

THE jury in the case of James O'Conner against the Galesburg (Ills.) Gas and Electric Company found a verdict for defendant. The case was a damage one, instituted by plaintiff to recover damages in $5,000, alleged to have been caused to property on West Main street owned by him, the damage arising from disturbing noises incident to the construction of a gasholder and from noxious odors arising from escaping of gas.

MR. F. N. TIDMAN, Manager of the Oklahoma Gas and Electric Company since 1904, has been succeeded by Mr. W. R. Molinard, who managed the Company's affairs during Mr. Tidman's absence in Europe. This is one of the Byllesby properties. Mr. Tidman will continue as Vice-President of the Oklahoma City Corporation, and will in all probability succeed to the general charge of all the Byllesby properties in Oklahoma, of which there are several.

THE Public Service Commission, of Cincinnati, O., last Thursday took up the protest of Oliver Goldsmith, against a minimum monthly rate by the Cincinnati Gas and Electric Light Company, which charge has been in vogue for some time. The complaint hearing is likely to be of exceptional interest to suppliers of lighting currents from central stations, in that another matter which will receive the close attention of the Commissioners has to do with the placing of electric meters.

DESPATCHES to the Chicago *Post*, of Nov. 23d, dated the day prior from Madison, Wis., are to this effect: "The State Railroad Commission took advanced ground to-day in laying down the principle that public utility companies which base rates on an exclusive valuation are not giving a square deal to the consuming public. In ruling against the Wisconsin Traction, Light, Heat and Power Company the Commission characterized the purchase of the gas plant at Appleton, by John I. Beggs, for a price over $500,000 as an 'unfortunate investment which should not be saddled upon the respondent Company's owners.' The Commission holds that the purchase price was not a prudent investment. The Railroad Commission recently ordered a reduction in the price of gas, from which an appeal was taken. The current ruling affirms the prior order."

THE plant of the Birdsboro, (Pa.) Gas Company is underway, excavating having been commenced on land purchased from the Smith section owners. The plot is located on the extreme eastern boundary of Birdsboro borough.

THE St. Louis (Mo.) *Times*, of recent date, declares that the new ½ million dollar plant of the St. Louis County Gas Company was put into active operation the night of November 17th, when the supply lines of the Laclede Gas Company were cut off at 42 points from the county. The new plant, which is in Shrewsbury section, on the Terminal Belt Line near the St. Louis city limits, has a daily capacity of 3 millions cubic feet. The closing of the supply contract with the Laclede Company means the limiting of the business of the latter to the city proper, save for a small supply to the Luxemburg district.

RECENT advices by way of Cedar Rapids, Ia., are to this effect: "The Ottumwa Gas, Light, Heat and Power Company changed hands this week, the property having been bought by the Western Utilities Company, a corporation with a full paid capital stock of $500,000 controlled by capitalists from Grand Rapids, Mich., and Chicago. The Western Utilities Company purchased all of the capital stock of the local Company, the majority of which was owned by T. J. Hackworth, A. G. Harrow and Frank McIntire. The deal was made by Frank T. Hulswit, Vice-President, and Richard Schaddelee, Secretary and Treasurer of the new Company. These officers, with Howard A. Thornton, general counsel for the different companies they are interested in, and L. H. Heinke, their General Auditor, completed the negotiations, which have been in progress for some time. I. C. Elston, formerly General Manager of the Ottumwa plant, and later General Manager of the Gas and Electric Company at Waterloo, who is well and favorably known here, is one of the men heavily interested with the new purchasers. The local Company will be reorganized in the near future, and an authorized issue of $750,000 of bonds will be placed by the Company. Of this amount, however, only $300,000 will be issued, the remaining $450,000 being retained in the treasury to be sold as the Company needs money to improve and extend its manufacturing plant and distribution system. The Ottumwa plant has 40 miles of gas mains, and the output for the year 1910 was 50,000,000 feet."

THE Iowa Central Railroad Company, prior to the trial of the case brought against it by the Hampton (Ia.) Electric Light and Power Company, for damages to the latter's plant caused by a fire started by sparks from a locomotive of the former, prayed for a change of venue. That is, it asked that the trial be brought in the Federal Court, at Fort Dodge, instead of the local court at Hampton, on the ground that a fair verdict could not be there rendered because of prejudice on the part of Hampton's residents. The venue was changed, the case was tried a fortnight ago, and the jury awarded complainant damages in the sum of $8,000.

Recent Patent Issues.

Prepared for the AMERICAN GAS LIGHT JOURNAL by ROYAL E. BURNHAM, solicitor of patents and counselor in patent causes, 833 Bond Building, Washington, D. C., from whom illustrations and specifications of any patent mentioned below may be obtained for 20 cents.

1,009,064. Gas Producer. O. A. Gobbe, Junet, Belgium, assignor to Emile Gobbe, same place.

1009,184. Igniter Torch for Gas Burners. J. F. Rutz and J. K. Leuthe, Milwaukee, Wis.

1009,313. Mechanism for Producing Gas Lighted Flash Signs and the like for Advertising Purposes. T. Jackson, New Cross, London, England, assignor to himself and A. Ramsay, Chesham, England.

1,009,379. Gas Burner. C. P. Bott, Leipzig-Sellerhausen, Germany.

1,009,448. Automatic Recording Apparatus for Measuring Gaseous Fluids. C. F. Simon, Stolberg, Germany, assignor to Chemische Fabrik Rhenania, same place.

The Market for Gas Securities.

The city market, as gas shares go, was irregular and uncertain, especially in respect to Consolidated, which developed a weakness that was altogether unlooked for. Why these shares should follow closely the movements of the general (or railroad share) market is unexplainable, but that such is the case may not be disputed. One reason, of course, is the ease with which it responds to sales on the short side, for the stock is never in any sense "protected," as that is meant in the vernacular of the street. In fact, many of the genus known as "pikers" have made for quite a while a comfortable living by confining their methods to "shorting" 50 shares or so of the stock and buying it back in quick order. Of course, the plan is a dangerous one.

Brooklyn Union is virtually as it was last week, the opening this morning having been made at 143½ to 145; other gas shares are fairly steady, although Lacledes went off a trifle more than is represented in the ex-dividend quotation. The feature of the week was the retirement of Mr. C. K. G. Billings, from the Directorate of the Peoples Gas Light and Coke Company, of which body he was also Chairman. His successor as Chairman is Mr. A. N. Brady, and his successor as Director is Mr. James F. Meagher, for years the Company's General Counsel.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

115 BROADWAY, NEW YORK CITY.

DECEMBER 4.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share:

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked*
Consolidated Gas Co.	$78,177,000	100	139	139½
Central Union Gas Co.—				
1st 5's, due 1928, J. & J.	3,000,000	1,000	103	105
Equitable Gas Light Co.—				
Con. 5's, due 1932, M. & S.	1,000,000	1,000	105	106
Mutual Gas Co.	3,600,000	100	155	165
New Amsterdam Gas Co.—				
1st Con. 5's, due 1948, J. & J.	11,000,000	1,000	100	101½
New York & Richmond Gas				
Co. (Staten Island)	1,500,000	100	35	50
1st Mtg. Gold Bds. 5 p. ct.	1,000,000	—	98¼	100½
New York and East River—				
1st 5's, due 1944, J. & J.	3,500,000	1,000	103	105
Con. 5's, due 1945, J. & J.	1,500,000	—	95	100
Northern Union—				
1st 5's, due 1927, J. & J.	1,250,000	1,000	94	100
Standard	5,000,000	100	61	70
Preferred	5,000,000	100	91	100
1st Mtg. 5's, due 1930, M. & N.	1,500,000	1,000	103	105
The Brooklyn Union	15,000,000	1,000	143½	145
1st Con. 5's, due 1948, M. & N.	15,000,000	—	105¾	107
Yonkers	200,650	500	130	—
Out-of-Town Companies.				
Bay State	50,000,000	50	½	¾
" Income Bonds	2,000,000	1,000	—	75
Binghampton Gas Works	450,000	100	—	—
" 1st Mtg. 5's	500,000	1,000	97	100
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	5	8
Bonds, 5's	5,250,000	1,000	59	60
Capital, Sacramento	500,000	50	—	35
Bonds (6's)	150,000	1,000	—	—
Chicago Gas Co. Guaranteed				
Gold Bonds	7,860,000	1,000	104	106¼
Cincinnati Gas and Electric				
Co.	29,500,000	100	87	90
Columbus (O.) Gas Co., 1st				
Mortgage Bonds	1,500,000	1,000	96	98
Columbus (O.) Gas Lt. &				
Heating Co.	1,682,750	100	90¼	91
Preferred	3,026,500	100	75¼	80
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	13,460,084	—		—
Mortgages, 5's	3,400,000	—		—
General Mortgage 4½	10,661,000	—		—
Con. Gas Co., Baltimore				
City, 4½	2,751,000	—		—
Consolidated Gas Co. of N. J.	1,000,000	100	15	—
Con. Mtg. 5's	976,000	1,000	92	95
Bonds	75,000	—	—	100
Denver Gas and Electric	3,500,000	—	102	105
Detroit City Gas Co.	6,580,000	—	—	50
" Prior Lien 5's	5,619,000	1,000	97	100¼
Detroit Gas Co., 5's	381,000	1,000	75	80
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	—	101
Essex and Hudson Gas Co.	6,500,000	—	135	138
Fort Wayne	2,000,000	—	—	—
" Bonds	2,000,000	—	55	—
Grand Rapids Gas Light Co., 1st Mtg. 5's	1,350,000	1,000	100	101
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	—	130	138
" Bonds, 5's	10,500,000	—	101	106
Indianapolis	2,000,000	—	—	38
" Bonds, 5's	2,650,000	—	104½	105
Jackson Gas Co.	250,000	50	82	—
" 1st Mtg. 5's	290,000	1,000	97	100
Kansas City Gas Light Co., of Missouri	5,000,000	100	—	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede Gas Co., St. Louis.	10,000,000	100	102	102 x
Preferred	2,500,000	100	114	120
Bonds	10,000,000	1,000	102⅜	103
Lafayette Gas Co., Ind.	1,000,000	100	—	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	143	145
Madison Gas and Electric Co.				
" 1st Mtg. 6's	400,000	1,000	106	108¾
Massachusetts Gas Companies, of Boston	25,000,000	100	90⅛	90¼
Preferred	25,000,000	100	95⅝	96
Montreal Gas Co., Canada	2,000,000	100	218	218¾
Nashville Gas Light Co.	1,000,000	100	110	—
Newark, N. J., Con. Gas Co.	6,000,000	—	97	98
Bonds, 6's	6,000,000	—	127	128
New Haven Gas Co.	2,000,000	25	200	—
Peoples Gas Lt. & Coke Co., Chicago	25,000,000	100	105¼	105⅜
1st Mortgage	20,100,000	1,000	—	—
2d "	2,500,000	1,000	104	—
Rochester Gas & Electric Co.	2,150,000	50	88	—
Preferred	2,150,000	50	118	—
Consolidated 5's	2,000,000	—	104¼	105⅛
San Francisco Gas Co., Cal.	15,500,000	—	—	—
St. Joseph Gas Co.—				
1st Mtg. 5's	1,000,000	1,000	94	98
St. Paul Gas Light Co.	2,500,000	100	—	—
1st Mortgages, 6's	650,000	1,000	104	108
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	3,447,000	1,000	94	96
Syracuse Gas Co., N. Y.	1,975,000	100	50	55
Bonds	2,047,000	1,000	101	103
Washington (D. C.) Gas Co.	1,600,000	200	439	440
1st Mortgage, 6's	600,000	—	—	—
Western Gas Co., Milwaukee	4,000,000	—	—	—
Wilmington (Del.) Gas Co.	600,000	50	129	—

MEETING TIMES OF THE VARIOUS GAS ASSOCIATIONS.

American Gas Institute.—Annual meeting, October, ——, 1912. Atlantic City, N. J. Officers: President, Ira C. Copley, Aurora, Ills. Secretary, Geo. G. Ramsdell, 29 West 39th st., N. Y. City.

Canadian Gas Association.—Annual meeting, ———— Officers President, Arthur Hewitt, Toronto, Ont.; Secretary and Treasurer, John Keillor, Hamilton, Ont.

Empire State Gas and Electric Association.—Next meeting, Syracuse, N. Y., Nov. 1911. Officers: President, R. M. Searle, Rochester, N. Y.; Secretary, C. H. B. Chapin, 29 W. 39th street, New York City.

Gulld of Gas Managers of New England.—Annual meeting, March, 1912. Young's Hotel, Boston; monthly meeting, second Saturday. Officers: President, Walter G. Africa, Manchester, N. H.; Secretary, H. K. Morrison, Brockton, Mass.

Illinois Gas Association.—Annual meeting, time, March, 1912, Chicago, Ills. Officers: President, C. B. Strohn, Elgin, Ills.; Secretary-Treasurer, F. E. Newberry, Dixon, Ills.

Illuminating Engineering Society.—Annual meeting, Sept. ————1912, ———— Meetings of Sections, monthly. Pres't, A. E. Kennelly, Boston, Mass.; Secretary, Preston S. Millar, 29 W. 39th street, N. Y. City. Sections: New York, Secretary, Albert J. Marshall, 16 East 40th street. New England, Secretary, H. C. Jones, 10 High street, Boston, Mass. Philadelphia, Secretary, L. B. Eichengreen, Broad and Arch streets. Chicago, Secretary, A. L. Eustice, 105 North Wabash avenue.

Indiana Gas Association.—Annual meeting, Jan. 17 and 18, 1912, Indianapolis. Officers: President, S. E. Mulholland, Fort Wayne; Vice-President, Howard L. Olds, Indianapolis; Secretary-Treasurer, Philmer Eves, Indianapolis.

Iowa District Gas Association.—Annual meeting, time, May, ——, 1912; Lincoln, Neb. Officers: President, G. W. Clabaugh, Omaha, Neb.; Secretary and Treasurer, G. I. Vincent, Des Moines, Ia.

Kansas Gas, Water and Electric Light Association.—Annual meeting, time, Sept. 1912. Manhattan, Kas. Officers: President, B. F. Fyer, Manhattan, Kas.; Secretary and Treasurer, J. D. Nicholson, Newton, Kas.

Michigan Gas Association—Annual meeting, time, Sept. ————1912;———— Officers: President, F. W. Blowers, Kalamazoo, Mich; Secretary-Treasurer, Glenn R. Chamberlain, Grand Rapids, Mich.

Missouri Electric Light, Gas, Water Works and Street Railway Association.—Annual meeting, April, 1912; St. Louis, Mo. Officers: President, F. E. Murray, Louisiana, Mo.; Secretary and Treasurer, N. J. Cunningham, Springfield, Mo.

National Commercial Gas Association.—Annual meeting, December, 1912 Atlanta, Ga. Officers: President, C. L. Holman, St. Louis, Mo.; Secretary, Louis Stotz, 29 West 39th street, New York City.

Natural Gas Association.—Annual meeting, May, 1912, Kansas City, Mo.; Officers: President, A. B. Macbeth, Independence, Kas. Secretary, T. C. Jones, Delaware, O.

New England Gas Association.—Annual meeting, third Wednesday in February, 1912 Boston. Officers: President, J. A. Coffin, Gloucester, Mass.; Secretary-Treasurer, N. W. Gifford, East Boston, Mass.

New Jersey State Gas Association.—President, William H. Pettes, Newark, N. J.; Secretary-Treasurer, Arthur H. Osborn, Belmar, N. J.

Ohio Gas Association.—Annual meeting, February 6 and 7, 1912, Columbus, O.; President, John M. Garard, Columbus, O.; Secretary-Treasurer, T. C. Jones, Delaware, O.

Oklahoma Gas, Electric and Railway Association.—President, Noel R. Gascho, Alva Okla.; Secretary, H. V. Bozell, Norman, Okla.

Pacific Coast Gas Association.—Annual meeting, Sept. ————1912, ———— Officers: President, W. Baurhyte Los Angeles, Cal.; Vice President, Henry E. Adams, Stockton, Cal.; Secretary-Treasurer, John A. Britton, 445 Sutter street, San Francisco, Cal.

Pennsylvania Gas Association.—Annual meeting, April, 1912, Williamsport, Pa. Officers, President, C. W. Butterworth, Millon, Pa; Secretary-Treasurer, William H. Merritt, Lebanon, Pa.

Society of Gas Lighting.—Annual meeting, December, 1911; monthly meeting, second Thursday. Place, New York City. Officers: President, Fred. S. Benson; Secretary, George G. Ramsdell, 254 West 39th street, New York city.

Southern Gas Association.—Annual meeting, April, 1912, Jacksonville, Fla. Officers, President, H. B. Hoyt, Jacksonville, Fla.; Secretary-Treasurer, E. D. Brewer, Atlanta, Ga.

Southwestern Electrical and Gas Association.—Annual meeting, April 27, 28, 29, 1912; Houston, Tex. Officers: President, J. E. Carroll, Beaumont, Tex.; Secretary, D. G. Fisher, Dallas, Tex.

Wisconsin Gas Association.—Annual meeting, May 15 and 16, 1912, Milwaukee, Wis. Officers: President, H. M. Buck, Waukesha, Wis.; Secretary-Treasurer, Henry Harmon, Milwaukee, Wis.